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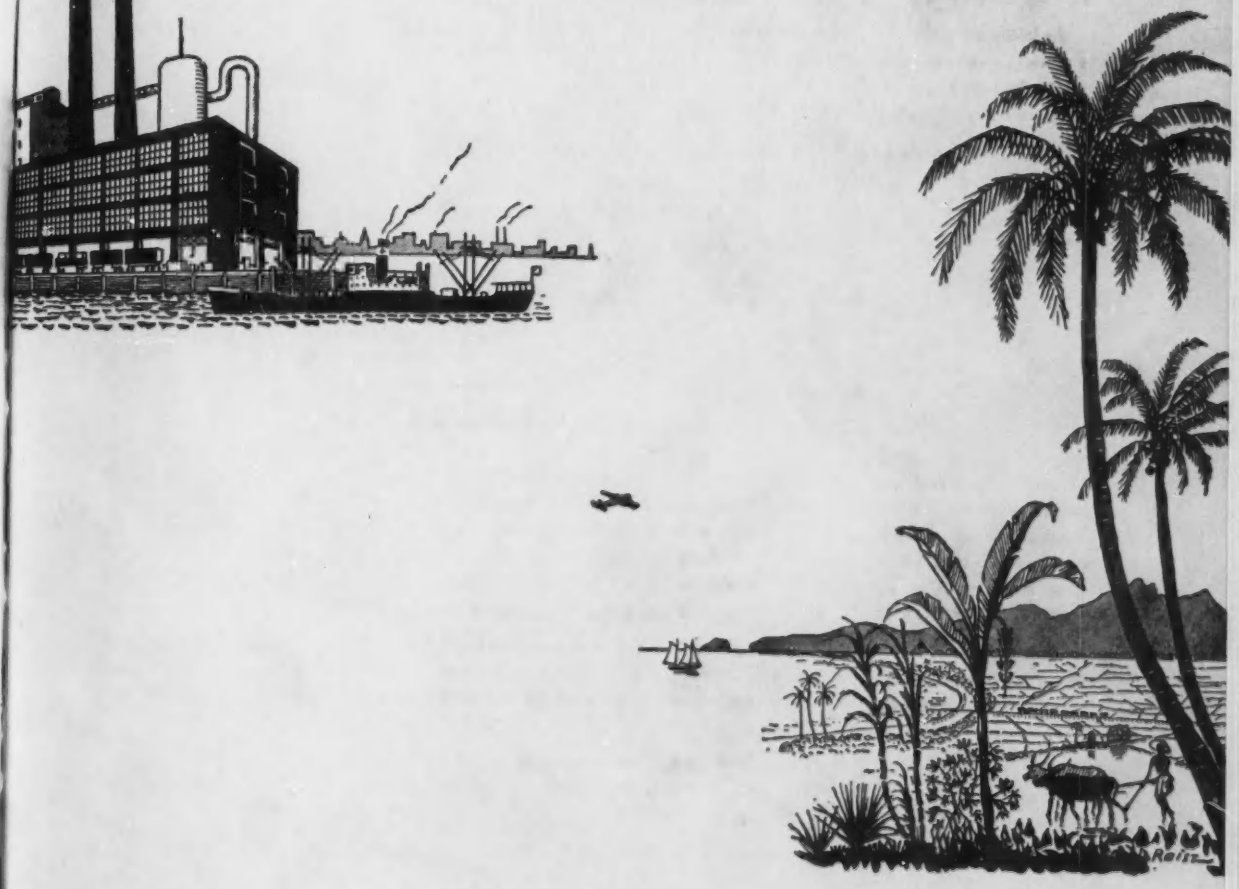

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ECONOMIC GEOGRAPHY

VOL. 30 OCTOBER, 1954 NO. 4

THE GROWTH OF PASTORALISM IN SOUTHLAND, NEW ZEALAND

Howard J. Critchfield

Assistant Professor Critchfield of the Western Washington College of Education, Bellingham, carried on his field work in Southland in 1948–50 while he was Visiting Lecturer in Geography at Canterbury University College, Christchurch.

SOUTHLAND, New Zealand, is the southernmost region of intensive commercial agriculture in the world. The distinctiveness and unity of the region arise largely from the nature of the pastoral economy in this most isolated portion of an isolated nation. In the time of the Maoris, before their early contacts with white men, Murihiku (Southland) was non-agricultural. Today it is a heavy contributor to New Zealand's exports of lamb, mutton, wool, and cheese.[1] A variety of factors have been influential in transforming the pre-European landscape of little more than a century ago into the present-day pattern of intensive pastoralism. Consideration is given here to the roles of these factors in the evolution of agricultural land use in Southland.

THE NATURAL ENVIRONMENT

The Maori name for Southland was Murihiku—"the last joint of the tail." Either Southland or Murihiku serves to imply its location at the southern extremity of New Zealand (Fig. 1). The Southland Land District has an area of 12,753 square miles, extending between latitudes 44° 30′ and 47° 20′ South. The land district is essentially the hinterland of the city of Invercargill and its associated port, Bluff.

The physiography of Southland is extremely diverse. Fiordland is a great tectonic block, rugged in relief and clothed in a dense rain forest, and must be written off as completely without agriculture. Across Foveaux Strait to the south Stewart Island has little more flat country than Fiordland. Small patches on slopes in the settled areas on the northeast side of the island have been cultivated or grazed and a grassy plain lies on the uninhabited west side along Mason Bay. But aside from these the island is essentially rugged and apparently lacking in land susceptible of agricultural development. The eastern portion of mainland Southland has a range and basin form[2] consisting of a series of low ranges and valley plains embracing the agricultural areas of Southland. Largest and by far the most important of these features is the Southland Plain, a wide deltaic

[1] See Howard J. Critchfield: "Pastoral Murihiku," *N. Z. Geogr.*, Vol. VII, 1951, pp. 1–20.

[2] C. A. Cotton: "Geomorphic Provinces in New Zealand," *N. Z. Geogr.*, Vol. 1, 1945, p. 44.

SOUTHLAND
LAND DISTRICT
0 10 20 30 Miles
NEW ZEALAND
0 100 200
Tasman Sea
FIORDLAND
Milford Sound
Lake Te Anau
Lake Manapouri
Lake Wakatipu
Queenstown
Kingston
Mataura R.
FIVE RIVERS PLAIN
Mossburn
Lumsden
Waikaia
TAKITIMU MTS
WAIMEA PLAIN
Mataura R.
Oreti R.
TARINGATURA HILLS
Aparima R.
Ohai
HOKONUI HILLS
Gore
Winton
Mataura
Tuatapere
Otautau
SOUTHLAND PLAIN
Edendale
Wyndham
Riverton
Invercargill
Tokanui
Bluff
Foveaux Strait
Mason Bay
STEWART ISLAND
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FIG. 1.

plain built up conjointly by the Aparima, Oreti, and Mataura Rivers. In general the Southland Plain is a mosaic of alluvial flats, river terraces, and undulating lowlands most of which are topographically suitable for farming. Around the Southland Plain is situated a belt of discontinuous maturely dissected uplands which fork out from north of Lake Te Anau. The Takitimu and Longwood Ranges in the west separate the Southland Plain from the broad terraced valleys of the Waiau and its tributary the Mararoa. To the north the Taringatura Hills and the Hokonui Hills partition off the Five Rivers and Waimea Plains. On the east the lower Mataura Valley is separated from the Clutha River in Otago by a triangular group of uplands through which passes the Southland-Otago boundary. Viewed broadly this range and basin portion of Southland is a large alluvial plain (Southland Plain) bordered on the landward side by a belt of discontinuous uplands beyond which in turn is a concentric catena made up of smaller terraced valley plains. Finally, an irregular arc of higher mountains is grouped around the whole.

The occurrence of limestone outcrops in the low ridges lying southward of the Hokonui Hills and in the Waiau Valley is one of the most fortunate features of the geology of the region, for great quantities of crushed limestone are applied to farmlands annually. Coal, the only other important mineral asset, is mined in the Ohai area and in the lignite beds of the Mataura Valley.

The position of Southland at the poleward end of New Zealand gives it a relatively cool climate dominated by the westerlies.[3] The winters are longer and cooler than in most other agricultural districts of New Zealand and grass growth ceases for about five months. Even in summer when more northerly districts are experiencing subtropical influences the Foveaux Strait area continues to have frontal passages. Invercargill has a mean January temperature of 57° and a July mean of 41° and is representative of coastal Southland. Farther inland the annual range is greater and winters are generally more severe. High country snow necessitates the practice of transhumance and even in recent years untimely autumn or spring snows have caused heavy sheep losses. Precipitation varies from well over 250″ on Fiordland's windward slopes to less than 30″ in the northern interior. In the agricultural heart east of Fiordland rainfall ranges from 35″ to 55″ and is well distributed throughout the year. Temporary droughts may be occasioned by a foehn type of wind in the northern valleys but moisture effectiveness is generally high and is reflected in part by the greenness of Southland's pastures throughout the summer.

The indigenous vegetation confronting the early settlers in Southland was principally forest and swamp species. Fiordland is clothed in beech-podocarp forest and has been set aside as a National Park Reserve. Stewart Island had a similar cover from which quantities of rimu or red pine (*Dacrydium cupressinum*) have been cut. In agricultural Southland beech (various species of *Nothofagus*, especially *N. Menziesii*) predominated in the west along the Waiau grading into mixed beech and podocarps toward the east. Areas of forest were interspersed with peat bogs and swamps which provided barriers to travel and agricultural settlement. In the northwest around Lakes Wakatipu, Te Anau, and Manapouri, in a

[3] The climatic regions of New Zealand are outlined in B. J. Garnier's "The Climates of New Zealand according to Thornthwaite's Classification," *Annals Assn. Amer. Geogrs.*, Vol. 36, 1946, pp. 151–177

FIG. 2. Overgrazed native tussock grassland in the Mararoa Valley. On the middle slopes of the mountains in the distance is beech forest (*Nothofagus*).

belt around the Hokonui Hills, and on the Waimea, Five River, Mararoa, and Waiau Plains the forest gave way to tussock grasses. The tussock country was in general suitable for early establishment of extensive pastoralism. The practice of burning the tussock cover provided a temporary pasture improvement but led to depletion of vegetation and subsequent soil erosion.[4] In the "bush" areas both cultivation and grazing had to await the clearing of trees and scrub from the land but fuel and timber were important by-products of this process. Even the lowly manuka (*Leptospermum scoparium*) makes excellent firewood.

The soils of Southland are varied as might be expected with the diversity of topography, climate, and vegetation. Conditions of poor drainage, high relief, or recency of deposition have resulted in a large proportion of azonal and intrazonal soils. These occur as lithosols in the mountainous areas, regosols on some coastal margins, alluvial soils in lower river valleys (especially the Mataura), and hydromorphic soils over the poorly drained lands in many parts of the Southland Plain and neighboring valleys. The valley flood plains and terraces are underlain with greywacke gravels, but these do not insure good drainage because of the common occurrence of claypans or in some cases ironstone pans in the subsoil. On the terraces of the interior valleys the greywacke shingle crops out at the surface giving large areas a stony surface soil. Excessive natural drainage on these stony soils produces droughty conditions in summer.

The zonal soils of the areas which had a natural beech and podocarp forest are podzolic in character but generally not maturely developed. The soils of the tussock grasslands are light and have a loose structure making them susceptible to erosion when the vegetative cover is removed. The most significant generalization that can be made about Southland soils is that they are deficient in calcium and phosphates and they are acidic. This applies alike to swamp, forest, and grassland. These deficiencies must be made up by application of crushed limestone and phosphatic fertilizers in order to maintain heavy growth of grass and crops. Deficiencies of "trace elements," notably cobalt, have also been discovered and addition of required elements to top-dressing or animal salt licks have proved beneficial.

THE PRE-EUROPEAN PERIOD

Prior to settlement by Europeans, New Zealand was occupied by the Maori race, a Polynesian people thought to have come to the islands in a series of migrations, beginning about 950 A.D. and reaching their most important phase with the coming of

[4] See Kenneth B. Cumberland: "A Century's Change: Natural to Cultural Vegetation in New Zealand," *Geogr. Rev.*, Vol. 31,. 1941, pp. 529–554.

the so-called Fleet Maoris about 1350 A.D. This latter group introduced four food plants into New Zealand: the yam (*Dioscorea alata*), the kumara or sweet potato (*Ipomoea batatas*), taro (*Colocasia antiquorum*), and the hue or gourd (*Lagenaria vulgaris*).[5]

Unfortunately, none of these crop plants could be grown in the climate of Murihiku. The yam could be successfully cultivated only in the warmer parts of the North Island. The kumara was grown only as far south as Temuka in South Canterbury, and this limit represented the division between agricultural tribes and those living from hunting and gathering.[6]

Taro and the gourd apparently were grown in the North Island only. The native cabbage tree (*Cordyline Australis*) and the bracken fern (*Pteridium esculentum*) were the principal vegetable mainstays of the Maori diet in the far south. The trunk and tap root of the cabbage tree provided starch similar to sago. Fern roots were a common item of food. However, the Murihiku Maori menu was dominated by sea food, especially shellfish, and birds. Thus we see that, whereas the Maoris of the North Island and parts of northern South Island had a relatively high standard of primitive agriculture, cultivation was entirely lacking in the south.

FIG. 3 (left). Cutover forest land near Tuatapere in the Waiau Valley. In this frontier region dairying and fat lamb production based upon sown grass pastures are replacing forestry.

FIG. 4 (right). Crop and pasture lands on the Waimea Plain. In the mid-distance the Mataura River meanders along the northern base of the Hokonui Hills.

WHALING AND SEALING, 1790–1850

It was not until the advent of whaling and sealing by Europeans and Americans in the waters to the south of New Zealand that cultivation was introduced into this part of the country.

The first recorded indication of cultivation in Southland is by a Sydney rope maker who visited Bluff harbor in 1813 in the course of investigating the possibilities of utilizing the native *Phormium tenax* as a source of fiber. He reported more than 100 acres of

[5] Elsdon Best: "Maori Agriculture," *Journ. Polynesian Soc.*, Vol. 39, 1930, p. 347.

[6] Cumberland has stated that the southern limit of kumara cultivation "was perhaps the most significant boundary in the country" in the late 1700's. See Kenneth B. Cumberland: "Aotearoa Maori: New Zealand about 1780," *Geogr. Rev.*, Vol. 39, 1949, p. 406.

potatoes growing in the Bluff area[7] and found that the chief items in the Maori diet there were fish and potatoes. The seed for these potato patches was obviously provided by whalers and sealers who frequented the vicinity from about 1792 and who traded with the Maoris for potatoes.

It is not known exactly when or by whom but other vegetables were introduced, probably also by whalers. An article published in Paris in 1826 describing the natives of the southern part of the South Island said:

> "As a rule the gardens are situated a certain distance from the houses. Potatoes, cabbages and other kitchen vegetables introduced by the Europeans are cultivated. During the winter season the potatoes are preserved by the same process as that employed by the Irish."[8]

In March, 1823, the "Snapper" arrived in Sydney, Australia, from the Foveaux Strait area with a cargo of "tow of phormium, skins of birds, articles of dress and objects of curiosity belonging to the natives."[9] The voyage of the "Snapper" had been chiefly for the purpose of collecting a cargo of phormium. On land as well as at sea early activities of the white man were directed toward the exploitation of the readily available resources. Phormium fiber was one of the few possibilities in Southland. By the late 1820's the seal herds had been so heavily depleted that ships were taking phormium, spars, potatoes, whale oil, and pork from Southland to complement their small cargoes of seal skins.

The peak of whaling activity followed that of sealing by a few years but the industry suffered the same fate. The establishment of whaling stations and the associated development of trade in garden produce represented the first important occupation of Southland by Europeans. In 1824 a settlement was begun at Bluff by James Spencer who developed trade with whalers. The settlement grew to include a whaling station, tavern, and store. It was James Spencer who imported the first cattle into Southland. He pastured cattle on the mainland, kept goats and pigs on islands off shore and grew crops of wheat, barley, potatoes, and vegetables.[10] Another settlement founded at Riverton in 1837 as a whaling station also engaged in farming to supply whalers. In 1843 this settlement had 25 acres under cultivation consisting largely of potatoes with some wheat and barley.

The contribution of the sealers and whalers was chiefly in their encouragement of coastal settlements which subsequently developed agriculture. The history of the whaling and sealing industries is one of wanton exploitation of these sea resources. Ninety per cent of the industry in the southern waters was controlled by American ships with over 18,000 seamen in the sealing and whaling areas south of Australia and New Zealand.[11]

The period of sealing and whaling operations in the waters south of New Zealand thus represents the early beginnings of European type agriculture in Southland. From the very outset it was commercial in nature and although emphasis has shifted from one crop to another, or from one livestock product to another, production for export has always been the keynote.

[7] Robert McNab: "Murihiku and the Southern Island," Invercargill, 1907, p. 14.

[8] McNab: *op. cit.*, p. 215. (Quoted from Nouvelles Annales des Voyages, Paris, 1826, Tome XXIX, p. 161, "An essay on the Manners and Customs of the Inhabitants of the Southern part of Tawai-Poenammou.")

[9] *Ibid.*, p. 208.

[10] F. G. Hall-Jones: "Kelly of Inverkelly," Invercargill, 1944, p. 35.

[11] J. B. Condliffe: "New Zealand in the Making," London, 1930, p. 115.

EARLY PASTORALISM

Southland was never a land of squatters in the generally accepted sense, nor was it an organized pioneer colony like the Wakefield settlements in Otago and Canterbury. A few of the earliest settlers secured land through the tribal rights of their Maori wives and others had the verbal permission of the natives to occupy their tracts. Still others purchased from the natives at various prices and obtained documentary title to their holdings.[12] Some of these titles were not recognized later, however, and "owners" had to give up their land or secure legal title to it. But full scale establishment of pastoral runs in Southland did not begin until the purchase of the "Murihiku block." The Constitution Act of 1852 had abolished the old provinces of New Ulster and New Munster, which had comprised New Zealand colony, and created a number of smaller provinces including Otago. Otago's territory included Murihiku, the boundary of which was nearly the same as that of the present Southland Land District except for Stewart Island. The deed to Murihiku was signed at Dunedin on August 17, 1853 by 58 members of the Ngaitahu tribe—the price £2,600.

By the middle of the nineteenth century whaling was on the wane and many of those who had been engaged in the industry began to make applications for runs and settled down to cattle or sheep raising. Curiously enough the proportion of skilled pastoralists among the early settlers was low, many of them being ex-seamen who had left the dying sealing and whaling industries. Most of the few early settlers with a background of sealing or whaling were English but when interior sheep stations were made available Highland Scots moved in either from the Scottish settlements near Dunedin or directly from Scotland. Names such as Campbell, Macdonald, McKenzie, Cameron, McNab, McKellar, and Menzies figured early in the history of Southland's land settlement and Southland's population remains today predominantly Scottish.

The development of the pastoral runs was the chief feature of Southland history in the five years following the purchase of Murihiku. The cattle and sheep for establishment of the early runs of Southland were chiefly from the north and were driven overland. Most of these were of an earlier Australian origin. However, a few sheep were imported directly from Australia through the harbor at Bluff. The shipping in of sheep from Australia and later the export of wool led to the designation of Bluff as a port of entry. Clark sums up the influence of Australia thus: "The character of agricultural and pastoral activity on the island (South Island) was probably influenced as profoundly by its location 1,200 miles beyond Australia on a sailing route from Great Britain which touched Australia first, as by the origin of the people or the environment to which they came."[13]

On the forested areas sawmilling and burning preceded grazing and cultivation. Sawmillers migrated through the country cutting the best timber and leaving the land to be burnt over and laboriously cleared of stumps by the cultivators and pastoralists who gradually moved in. It is not surprising therefore that the early pastoral runs were developed on the tussock country of the northern part of Southland where the natural grass cover

[12] F. G. Hall-Jones: "Historical Southland," Invercargill, 1945, p. 52.

[13] A. H. Clark: "The Historical Explanation of Land Use in New Zealand," *Journ. Econ. Hist.*, Vol. 5, 1945, p. 230.

provided the basis for immediate grazing.

Exploration of the interior was carried on principally by runholders in search of new grazing lands. The size of many of the runs particularly in the higher country ran into several thousand acres. Although the large acreages sound impressive, if such features as altitude, nature of the grass, relief, and isolation are considered the opportunity of the runholder appears in a different light. Establishment and maintenance of a run required capital and ability as well as a realistic courage.

Sheep men had to contend with such marauders as the wild pig and wild dog, both of which destroyed large numbers of sheep in the early days. A poisonous native shrub, tutu (*Coriaria ruscifolia*), also claimed many cattle and sheep before it was brought under partial control. Not the least of the problems was the rabbit menace which became serious in the 1870's and brought devastation to large areas of grassland. One of the greatest enemies of the early sheep farmer was scab disease caused by a minute insect which burrows under the skin of the sheep producing loss in condition or possible death. This pest was virtually eradicated by 1875 by means of widespread dipping of sheep in a "tobacco wash." Heavy or untimely snows also took heavy tolls of sheep in the high country. With these difficulties to face the runholder was as likely to go bankrupt as make a fortune. The general occupation of Southland by pastoral runs was destined to be a passing phase of development, but during that phase runholders were instrumental in opening up the more remote areas and did much to help solve the problems of pastoralism.

There was no complete land survey for some time after Murihiku was opened up so that the definition of property boundaries was rather vague. Applications for a run were made to the Commissioner of Lands in Dunedin stating the approximate boundaries, area, and grazing capacity. The settler was required to stock his run and was granted a grazing license for 14 years, subject to cancellation if the land should be required for a closer settlement. He was assured of the right to purchase the area containing his home and buildings. For ten shillings an acre he could purchase 80 acres at one of the stations and 10 acres at each of the other stations erected on his run.[14]

SOUTHLAND'S SHORT HISTORY AS A PROVINCE

After the purchase of the Murihiku block the Province of Otago began the gradual survey and sale of land to raise revenue. Runs were broken up and even though this was specifically provided for under the terms of the license the runholders of Southland objected strongly to the procedure. The Otago Provincial Council passed the Land Sales and Leases Ordinance in 1856 providing for the sale of 600,000 acres of land in blocks of not less than 2000 acres at ten shillings an acre. This ordinance made no stipulation that the purchaser must effect improvements on his land. Southlanders felt this would retard farm development and encourage land speculation. Furthermore, they complained that the revenue from sale of land in Southland was being used for government works in northern Otago. The isolation of Southland from the rest of Otago also contributed to a political rift. But in the early policy relative to pastoral lands lies the basis of the separation of Southland from Otago. After numerous meetings and petitions, not all

[14] W. R. Jourdain: "Land Legislation and Settlement in New Zealand," Wellington, 1925, pp. 86–87.

of which were fully supported by Southland's population, the Province of Southland was created on April 1, 1861. Invercargill had been surveyed in 1856 as a port settlement and was designated as the capital. The new province included the area between the Waiau and Mataura Rivers with a line from Lake Manapouri to Eyre Peak as the northern boundary. Foveaux Strait formed the southern limit but Stewart Island was added later.

From the beginning Southland province had a stormy life. Internal dissention and financial difficulties were its undoing. The discovery of gold in Otago in the year of separation caused widespread doubt as to the wisdom of the move. Nevertheless, Southland did experience a "gold boom" which had a direct effect upon her agriculture. The gold fields of western Otago were more accessible from the Invercargill-Bluff gateway than from the port of Otago at Dunedin. The use of this approach resulted in the building of business houses in Invercargill and at way-stations to the north. Naturally there was a sudden increase in land prices. A total of 7000 ounces of gold actually was shipped through Bluff but unfortunately for Southland the export duty went to Otago. However, the demand for agricultural products was greater than could be immediately met by the farmers of Southland.

Southland as a province was at its zenith in 1863. Stewart Island was annexed in that year. In 1861 the population had been 1820; in 1862 it was 3455 and in 1863 it jumped to 9545. Six immigrant ships landed their passengers at Bluff in the latter year. In the years 1862-1864 nearly 1400 settlers arrived at Bluff from abroad.

Quite apart from the possibilities of gold a concerted effort was made to encourage agricultural settlers to come to Southland. Several advantages were pointed out to prospective immigrants, among them being the mildness of climate as compared with North America. At about this time the American Civil War was also a deterrent to British emigration in that direction. Favorable comparisons with the other provinces of New Zealand were systematically made in a pamphlet issued for distribution in Great Britain.[15] There were certain advantages claimed for Southland. There was freedom from Maori trouble. The province had a large area of accessible land, much of it within 20 miles of Invercargill. Timber and wood for fuel were available on most tracts. The climate was similar to that of England. Finally, the land regulations were simple. A man could "apply one day and own land the next."

The indirect economic stimulus of the gold rush to the north, the sale of lands in the Province, and the growth of population gave undue confidence to the provincial government which proceeded to over-extend itself financially. By the end of 1864 Southland's population had dropped to 8085 and a debt of £388,000 had been accumulated. Finally the desirability of a reunion with Otago could no longer be ignored and on October 6, 1870, Southland was reunited with Otago Province.

During the period of separation exports from Southland totalled approximately £200,000. Of this four-fifths was wool. There was some grain and over £5,000 worth of preserved meat. Less than £10,000 in gold actually mined in Southland figured in the exports.[16] Southland was to have a history dominated by agriculture from an early date.

[15] "A Description of the Province of Southland, New Zealand," Invercargill, 1866, p. 13. (Published by Harnett and Co.)

[16] Hall-Jones: *op. cit.*, pp. 156 and 178.

STEWART ISLAND

Stewart Island was added to Southland during the period of the Province and the nature of settlement there deserves separate treatment. One of the principal factors retarding early agricultural settlement on the island was the land policy (essentially that of Otago) during the crucial years when settlers might otherwise have been disposed to tackle the dense forest, poor soils, boggy land, broken relief, and damp climate. The lack of an official survey of lands on the island made the holdings of settlers insecure and as a consequence they refrained from building fences and clearing land which they could not be certain of holding legally. The history of Stewart Island has therefore remained chiefly one of fishing with a prolonged period of timber exploitation. Its economy is essentially the same today as it was a hundred years ago. Timber for construction was first cut in 1826 at Port Pegasus, and early sawmilling was the basis of boat building in connection with whaling. The limited distribution of rimu confined sawmilling to the north of the southern shoreline at Paterson Inlet. Timber production came to an end in 1931 at Maori Beach on the north coast with the closing down of the last sawmill.

The first pastoral run on Stewart Island was constituted in 1879.[17] Previous to that there had been no successful sheep rearing though sheep had been kept for fresh meat. The run was located on the flat between Mason Bay and the forested mountain slopes to the east and included 5000 acres. A flock of 1600 sheep was built up at one time, but it was found that the area would support only about 1000 adequately. Although runs with a total area of 25,000 acres have at one time or another successfully carried sheep on Stewart Island this run has been the only one in continuous occupation to the present time. The relative inaccessibility of the island, the problems of transport and communication within the island, and the general unsuitability of the physical environment for cultivation or grazing have played their parts well in limiting agriculture there.

[17] Basil Howard: Rakiura, Dunedin, 1940, p. 312.

STANDARDIZATION OF LAND POLICY AND LAND SUBDIVISION

When the Provinces of New Munster and New Ulster were broken up and several smaller provinces created the powers of the provincial governments were great enough to permit separate land laws. As we have seen the separation of Southland from Otago was brought about by the objection to the land policy of the Otago provincial government. Southland itself passed several acts relating to waste land sales during its short provincial history.[18] But the variance in land legislation among the provinces was confusing both to the settlers and the central government. Furthermore there were increasing disparities in the financial and political organizations.

The land policies of the provinces were the underlying cause of the breakup of the provincial system. Land grabbing and speculation led first to a land boom and then to heavy indebtedness in many of the provinces. The Otago and Southland Reunion Act of 1870 provided that the land laws in the two parts were to continue in force until altered or repealed and created separate Waste Land Boards and Commissioners of Crown Lands. In 1876 the Abolition

[18] These are outlined in Jourdain: *op. cit.*, pp. 89–90.

Bill became effective bringing an end to the provinces and creating instead a system of local governments under a stronger central authority. The lands of the colony were placed under the control of land boards which were to operate under the policies of Parliament.

> "The damage, however, was done. Under provincial rule, especially in the later stages when abolition was clearly imminent, waste lands had been sold recklessly."[19]

The Land Act of 1877 was one of the first positive steps in consolidating the land policy. It repealed 56 "acts, ordinances and regulations." Subsequent laws amended and revised the land legislation. One of the most important series were the Lands for Settlement Acts which began with the Act of 1892. Under these acts large pastoral runs could be purchased by the government and subdivided into farms. This trend was inevitable and its effects spread early to Southland. Increasing taxes, economic vicissitudes, and the evolution of a new type of land use also served to break up the larger holdings.

THE LAND COMPANIES

In the late nineteenth century large blocks of land in Southland were held by two powerful companies, the New Zealand and Australian Land Company and the New Zealand Agricultural Company. The former held at one time 125,000 acres of land between Woodlands and the Mataura River as well as 700 acres on the Aparima River and 5000 on the Oreti. The largest block was known as the Edendale Estate. The activities of this company had a profound influence on Southland agriculture. Because of its financial resources various experimental phases of development could be carried out which later proved valuable to small farmers in Southland. The company imported steam engines for plowing and cultivating, built roads and bridges, exerted its influence to have the railway constructed from Invercargill to Gore, and by 1878 had expended £57,500 on buildings and fencing and £219,000 on cultivation and seeding projects. In 1878 the estate was carrying 62,000 sheep and 5700 cattle.[20] However, in spite of these impressive figures, expenditures exceeded immediate returns and the company decided to dispose of its land.

The decision to break up and sell the Edendale Estate was one of the significant steps in the history of Southland's agricultural production. Sale of agricultural land where a company with financial backing had admitted defeat was not a simple matter. Accordingly an experiment in dairying was begun with an original herd of 300 cows. Subsequently, the first permanent cheese factory in New Zealand was established at Edendale in 1881.[21] A government bonus of £500 was awarded the factory for the first export of 50 tons of cheese from New Zealand. This came from its second season's output in 1882–83. The success of this enterprise attracted to the Edendale Estate tenants and purchasers who took up dairy farming and supplied the Edendale factory. The first butter making industry in New Zealand was also developed at Edendale. The "Dunedin," which sailed from Port Chalmers to England with the first shipment of frozen meat on February 15, 1882, also carried some butter "probably made at the Edendale Dairy

[19] *Ibid.*, p. 106.

[20] Hall-Jones: *op. cit.*, pp. 178–179.

[21] Evidence points to an earlier cheese factory which operated on Otago Peninsula for about ten years from 1876. *N. Z. Journ. of Agr.*, Vol. 43, 1931, "Otago's Early Dairy Factory History," p. 95.

Factory."[22] Thus with the waning of the New Zealand and Australian Land Company came the beginning of one of the principal phases of Southland agriculture—dairy farming. Problems of drainage, soil deficiencies, and climate had yet to be solved but a form of intensive land use had been established which pointed the way to greater productivity from Southland's soil. The company further contributed to this trend by providing free "shell" lime to farmers who settled on subdivisions of the Edendale Estate.

The New Zealand Agricultural Company held a larger area in Southland but was not so significant in the development of farming as its contemporary. Its holding comprised 309,000 acres, mostly on the Waimea Plains and in general was land more difficult to develop. When the Waimea Plains branch railway was constructed from Gore to Lumsden in the middle 1880's the company began subdivision and sale of its property. The tenure of the New Zealand Agricultural Company may be regarded as a transition stage from large blocks to smaller farms since much of its property had been acquired in the form of pastoral runs.

REFRIGERATION

Probably the most significant event which helped to intensify pastoralism in New Zealand was the development of refrigeration and refrigerated ships. In Southland it was one of the dominant factors in hastening more intensive use of the land. The first boat load of frozen meat left Port Chalmers in February, 1882, and the first shipment from Southland occurred in May, 1883. At first sheep were killed at West Plains and then taken by rail to be frozen on the ship at Bluff. In 1886 a refrigerating plant was set up at Bluff and in 1887 approximately 20,000 carcasses were exported. Freezing works now operate at Mataura, Makarewa, and Ocean Beach (Bluff) and frozen lamb and mutton have become a leading export of Southland.

Refrigeration opened up an entirely new phase in pastoral production for there was a large and growing market for meat in the British Isles. Previously wool had been almost the sole pastoral product exported. Sheep carcasses were "boiled down" for the tallow, but this commodity ran a poor second to wool. Suddenly the sheep became worth three or four times as much as formerly. At this time there were also important developments in pasture improvements. These, combined with the new market, formed the basis of an intensive pastoral economy. On the flatter lands at least it was no longer necessary for a farmer to hold extensive areas of grassland. He could, with a market for both meat and wool, do a much more efficient job of primary production on a smaller tract of land. Whereas the flocks of Southland had been dominated by Merino type sheep with wool production the chief goal, they now changed to Romney Marsh and Southdown breeds producing fat lambs and mutton with wool assuming a corollary position. The new market created a greater incentive to concentrate on better pastures and better breeding. Higher land prices were the result. This in turn operated as one of the factors in decreasing the size of holdings.

Although commercial dairying had already had a small scale beginning in Southland the shipment of butter and cheese to antipodal markets could not become an economic reality until the advent of refrigeration. The market

[22] H. C. Philpott: "A History of the New Zealand Dairy Industry, 1840–1935," Wellington, 1937, p. 37.

TABLE I*

POPULATION AND LAND USE, 1900–1950

	1900	1910	1920	1930	1940	1950
Rural population	30,949	36,249	34,772	35,100	36,280	34,780
Land occupied (acres)	.....	3,164,134	3,180,633	3,288,982	3,236,987	3,054,575
Land cultivated or sown to grasses	964,253	1,180,277	1,299,509	1,363,375	1,312,102	1,401,135

*Tables I–III were compiled from New Zealand Official Yearbooks, Statistical Reports on Agricultural and Pastoral Production, and Annual Statements of Accounts and Returns of Bluff Harbour Board.

for cheese and butter in Australia was limited and competitive. The principal competitor for the British market was Denmark, but by strict attention to quality and efficient production methods coupled with "Empire preference" New Zealand was able to capture her share of the British market with the aid of refrigerated ships. In Southland, cheese became one of the leading exports and this region is the only part of the South Island which has figured significantly in the export of dairy products.

It is necessary to keep in mind that refrigeration, influential as it was in shaping the course of Southland's agriculture, was not the only factor. But if we disregard the possibility of some other satisfactory preserving process it appears likely that many of the areas of Southland now devoted to fat lambs and dairying would instead be fields of wheat or oats. The population of New Zealand is relatively small and constitutes only a minor proportion of the market for agricultural products. Southland's production, like that of the other districts, depends therefore on overseas markets. The farm settlers in Southland had a background of mixed farming experience. They introduced English methods and English grasses adapting them where necessary to fit the Southland conditions. From the very beginnings of organized settlement pastoralism was the keynote. Refrigeration was the one link needed to bridge the gap between the meat and dairy producer and the British market. Clark writes of "the undue importance usually attached to the advent of marine refrigeration as a revolutionary factor in determining the patterns of land utilization in the [South] Island."[23] He admits that it had "just such an effect in the opening up of the North Island and in determining the course of agricultural and pastoral activity there." It is difficult to visualize the present intensive production of fat lambs and dairy products in Southland without a means of marketing them. There is little doubt that the large runs of the lowland areas would have been broken up in time regardless of refrigeration. The meat canning industry had its beginnings earlier than refrigeration and but for the latter would probably had enjoyed greater prosperity.[24] Assuming the absence of meat preserving methods, only a speculative conclusion can be drawn regarding the present-day agricultural economy. Consideration of past production and export data lead to the belief that wool and small grains would top the export lists.

RAILWAYS AND ROADS

The prime essential for the consolidation of the hinterland of an export port is a transportation system. In South-

[23] Clark: *op. cit.*, p. 229.

[24] Hall-Jones mentions a record of over £5,000 worth of "preserved" meat being exported from Southland prior to 1871. *Op. cit.*, p. 178.

TABLE II

ANIMAL NUMBERS, 1900–1950

	1900	1910	1920	1930	1940	1950
Sheep and lambs	1,232,078	1,688,288	1,601,640	2,652,593	3,026,984	3,534,013
Dairy cows	25,990	37,138	57,439	71,165	65,652	51,933
All cattle	77,802	89,927	165,380	170,967	148,283	173,397
Horses	20,538	29,750	29,108	24,117	23,858	13,522

land this was accomplished chiefly by railways, most of which were constructed in the latter third of the nineteenth century. The first line had wooden rails and ran from Invercargill to Makarewa beginning in 1864. Of greater significance, however, was the line to Bluff which was opened in 1867, giving an impetus to the development of Bluff Harbor. Previously three-fourths of the imports into Southland were landed at the New River Harbor (Oreti River mouth) and nearly all of the goods landed at Bluff was lightered around to the New River.[25] The filling of the New River Harbor by silt and sand dunes made the shift to the port at Bluff expedient. Other important lines, all constructed before 1880, run to Kingston at the south end of Lake Wakatipu, to Riverton at the mouth of the Aparima, and through Mataura and Gore to connect with Balclutha and Dunedin in Otago. Branch lines subsequently reached small centers off main routes.

Development of a suitable network of roads was a slow process largely effected since the advent of motor vehicles. The earliest roads were muddy and at times impassable and many pastoral runs were virtually inaccessible by wagon during the winter months. However, the tracks to remote pastoral runs were the beginning of many of the present-day routes to the interior. River navigation never played an important part in transport so that roads and trails were the means of early commerce.

[25] *Ibid.*, p. 171.

THE TWENTIETH CENTURY

By 1900 dairy products and frozen meat had taken up a firm position with wool and grain in Southland's exports, and they have maintained high rank in the export lists to the present. At the turn of the century oats was the leading export crop of Southland, but with the advent of mechanical transport and tractors the horse was replaced and there was a falling off in the Australian as well as the domestic market. Some oats farmers switched to grass seed production but most of them turned to sheep and fat lambs. The changes in agriculture in Southland in the past half century have been in the intensification of land use and the application of scientific knowledge to further increase production. The patterns of land use and the basic character of production have altered only in details and yet with a virtually stable rural population during the first half of the twentieth century there has been a marked increase in agricultural output. The total value of exports from Bluff (almost wholly agricultural products) increased from £741,750 in 1900 to £10,252,797 in 1948. In the same period the net increase of rural population was less than 6 per cent.

In 1893 there were 206,716 sheep and 65,391 lambs killed and frozen for export from Southland. In 1950 the killings were 293,574 sheep and 2,015,206 lambs.

TABLE III

EXPORTS, 1900–1950

	1900	1910	1920	1930	1940	1950
Wool (bales)	25,597	33,645	42,285	36,624	78,195	94,628
Frozen meat (long tons)	7,541	11,206	18,533	15,110	29,501	44,600
Grain (long tons)	37,585	15,185	7,637	9,412	7,171	1,844
Cheese (long tons)	1,460	3,950	7,280	13,777	13,642	10,919

Wool exports rose from 25,597 bales in 1900 to 142,999 bales in 1947. The total sheep population was 1,232,000 in 1900; in 1950 it was 3,534,000. By way of contrast grain exports fell from a high of 78,871 long tons in 1901 to 1844 tons in 1950. Tables I, II, and III show the rural population by decades since 1900 with corresponding figures relating to agriculture and exports.

There are several reasons for the increase in production during the past 50 years. The tables show that increase in cultivated area, occupied area, or population are not sufficient explanations in themselves. The upward trends in production stem rather from improved farming and processing practices which may be summarized thus:

(1) Mechanization. In 1921 there were 32 agricultural tractors in all of Southland. By 1947 there were 2326. The displacement of the horse permitted more economic utilization of pastures and feed formerly needed for its upkeep. Mechanization in the handling and processing of dairy products and meat also contributed to the greater production for export. The paucity of farm labor has made the introduction of machinery imperative in many instances.

(2) Limestone and fertilizers. The use of crushed limestone and phosphates have greatly improved fertility of soils with consequent increased grazing capacity of pastures and higher crop yields. Recognition of the importance of trace elements and their application in top dressing has been quite as significant as universal "liming."

(3) Development of better grass strains with higher nutritional value, greater palatability, and faster rate of growth. Much of this work has been carried on outside Southland but the results have been applied to advantage.

(4) Controlled grazing, especially in dry weather, thus prolonging the life of the pastures.

(5) Improved breed types of sheep and dairy cattle.

(6) Increased provision of supplementary winter feed crops. Associated with this has been a tendency toward more haymaking and less reliance on turnips and swedes.

(7) Reduction in lamb losses through better care at lambing time and more shelter belt plantation for protection.

(8) Land drainage both on crop and grasslands. In the past 40 or 50 years land drainage has been employed largely as a means of improving areas already occupied rather than in the reclamation of completely unproductive areas. Mechanical ditch-diggers, drag-lines, and drain plows have expedited this work.

(9) Rabbit control. The beneficial effects of rabbit destruction have been felt chiefly in the more densely settled lowlands. Unfortunately, the problem is still acute in many areas.

(10) Development of by-product industries, e.g., whey, butter, and lactose.

(11) Improvement in motor transport and roads making intensive farming

economically possible in more remote areas. In particular this development has made possible the collection of milk from greater distances to supply cheese factories.

TRENDS IN LAND USE

In the past 50 years in New Zealand there has been a general trend of population away from the land, as well as a drift to the North Island. These changes have been compensated for by concomitant trends in the character of pastoralism. Fat lamb production has tended to replace dairying because it requires less labor. During the first years on a farm the regular income from dairying was almost an economic necessity for many farmers, but as a farmer "became financial" he turned increasingly to fat lamb production which brings greater returns per unit of labor and is less demanding in its work routine. This transition is still going on in some of the areas of recent development. Associated with the changeover several cheese factories have closed in recent years partly due to a decrease in dairying in some areas but also as the result of better transport methods which have permitted consolidation of processing facilities. The trend to greater emphasis on fat lamb production has been accompanied by a falling off in the proportion of beef cattle as well, but beef production has again increased in the post-war years. As the sheep numbers have increased wool production has climbed and wool continues to lead all exports in point of value. The agreement between the New Zealand and United Kingdom governments which guarantees the purchase of New Zealand's meat supply until 1955 has stimulated this trend. The combination of fat lamb and dairy production on the same farm in many cases has made the shift to increased lamb output a relatively simple one. For this reason the trend is not necessarily irreversible.

The effect of World War II on Southland's primary production was reflected principally in grain production which was stepped up during the war and post-war years. Grain exports in 1940

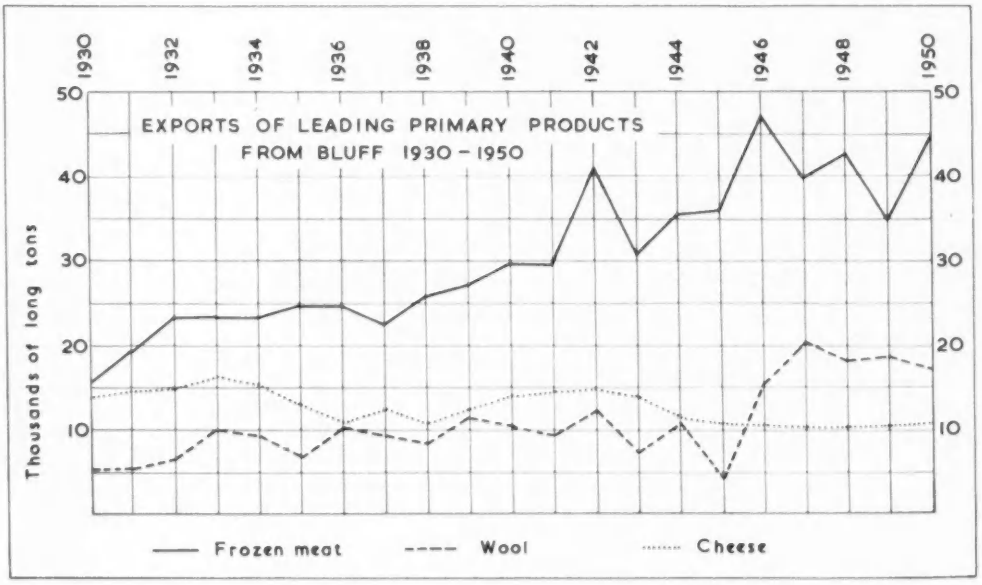

FIG. 5. Graph of exports of leading primary products from Bluff, 1930–1950.

were 7171 long tons but had increased to 13,952 tons in 1947. Most of this was shipped to the North Island rather than abroad but nevertheless represents an indirect response to the greater world demand and higher prices for grains. The accompanying graph illustrates the increase in export of frozen meat and wool since 1930 and the slight decrease in cheese exports over the same period (Fig. 5). Note that the disruption of shipping by the war is reflected in the fluctuation of exports in the years 1940–44. In the case of wool there was considerable stock-piling to await shipping; frozen meat and cheese were not stored in great quantities but were sent by rail to Port Chalmers and thus do not appear in Bluff export statistics.

SOUTHLAND TODAY

Southland exhibits a high standard of agricultural land use centering on the exotic verdure of the Southland Plain. One is impressed by the neat farmsteads with their well kept buildings. Gorse hedges give the undulating lowlands an orderly appearance resembling the English countryside. Shelter belts of exotic trees criss-cross the landscape. The high carrying capacity of the pastures of ryegrass, clovers, cocksfoot, and timothy is amply demonstrated by the thousands of grazing sheep, lambs, and cattle. As in most of the rest of New Zealand, Southland farms are without barns. Shelterbelts, hedgerows, and cow covers are substituted. Nevertheless, most farms do have the characteristic wool shed. Thousands of acres are crossed and recrossed by drainage ditches and underground tile and mole drainage systems. Planting, cultivating, and harvesting are well mechanized operations. The horse population is at its lowest total in this century, and many of these are kept as racing animals rather than for farm power. Stacks of hay and fields of turnips, swedes, rape, chou moellier, and other succulents are characteristic features of the landscape in late summer and autumn, for grass growth stops in winter and feed has to be provided in greater quantities than in the northern districts of New Zealand. Grass seeds and small grains are common crops but the latter are grown as often for green feed or hay as for grain. The chain of limeworks along the ridges south of the Hokonui Hills have become established prerequisites of efficient grassland farming. Forty-three dairy factories and three freezing works are just as necessary to handle the products of that grassland farming.

On the periphery of this agricultural heart, farming becomes less intensive, merging eventually into unoccupied mountains, forests, or coastal swamps. On the high and slightly drier plains and terraces grass seed production is important. Fat lambs and dairying give way to beef cattle, store sheep, and wool as the source of income in the outlying tussock and scrub covered hills. Farmsteads are more scattered and there are signs of shallower soils, erosion, gorse or other weed infestation, and too many rabbits entering into competition for the exiguous grass. Along the Waiau at Tuatapere in the west and east of the Mataura River in the southeast fat lamb and dairy farms are replacing the forest. East and south of Invercargill there is a slow tendency toward drainage of swamps and clearing of bush to expand agricultural output. In Fiordland and on most of Stewart Island one finds the complete antithesis of the agriculture of the Southland Plain. Here there is no settlement let alone agriculture. Indeed large sections of interior Fiord County have not been penetrated by white men.

Southland has had organized agricul-

ture for well over a century. The location, physiography, climate, and soils form a physical environment which has set broad limits influencing the agricultural development during the past. The present emphasis on fat lambs, wool, and dairying is a far cry from the earliest potato patches. This transformation has resulted not from man's complete mastery of the environment nor from the dominance of man by his environment but rather from an interaction of the two. The farmer has had to bow to elimate in his choice of crops and many of his management practices. Indeed climate has been one of the principal factors giving distinctive regional character of Southland's agriculture. But the fact that the immigrants came from a comparable climate in the British Isles and introduced English methods and English grasses also had a share in shaping the geographic character of the region and in advancing pastoralism to such a high level of productivity.[26] Land laws, wars, scientific experimentation, agricultural education, refrigeration, transportation, fluctuating world markets, the Otago gold rush, whaling and sealing, and the introduction of exotic pests are all factors which had some measure of influence in the evolution of Southland's agricultural practices.

The contribution of Southland's agriculture to the world is more than the mere introduction of primary produce into world commerce, important as that is. The agricultural economy of the region is a working example of the ability of man to make a compatible and purposeful adjustment to his physical environment. Many of the world's peoples now striving to bridge the gap between supply of food and demand for food would do well to study the man-land relationship and the agricultural prospects of Southland, New Zealand.

[26] This theme is dealt with in detail in A. H. Clark: "The Invasion of New Zealand by People, Plants and Animals," New Brunswick, N. J., 1949.

A COMPARATIVE STUDY OF NINE CENTRAL BUSINESS DISTRICTS*

Raymond E. Murphy and J. E. Vance, Jr.

THE Central Business District (CBD) of the American city is so familiar to the average citizen that he is likely to take it for granted. Under one name or another, it is thought of as an area of urban concentration that has been in existence since the beginning of the city and that will last as long as the city endures. But the CBD, as it is known today, is relatively modern, and its place in the city of tomorrow is a subject of wide debate. This uncertainty is based upon the many problems with which planners and other students of the city are grappling.

To meet these problems, a better understanding of the district is necessary, and this cannot be attained through concentrating on any one city. Instead, comparative studies are needed, just as they are in many other phases of urban research. This paper is one of the products of such a study, dealing with the CBDs of nine cities—Worcester, Massachusetts; Grand Rapids, Michigan; Salt Lake City, Utah; Tacoma, Washington; Sacramento, California; Phoenix, Arizona; Tulsa, Oklahoma; Mobile, Alabama; and Roanoke, Virginia.

A comparison of CBDs involves several steps or phases. First is delimitation on a standardized basis, without which the comparison would mean little. Techniques of delimitation were discussed in an earlier paper, and the nine districts were delimited.[1] In the current paper, the CBDs will be compared on the basis of the total picture that each presents. The third and concluding paper of the series will deal with the internal structure of the CBD as far as it may be inferred from the nine districts studied.

Elements of the Problem

In the total aspect that each presents, CBDs differ from city to city in size, in shape, in orientation, in location within the urban area, in land use, and in other aspects as well. These CBD variations may be considered in relation to site, regional setting, city area, city population, extent and buying power of trading area, city age, economic support of the city, wholesale trade, retail trade, and other general background information.

In the comparison presented in this paper, CBD differences form one element, and relevant background information a second (Tables I and II). But it is necessary to keep in mind still a third element: the special characteristics imparted by the delimitation technique used. For example, the delimitation was done on a block basis. Also, a distinction was made between certain forms of land use that were regarded

*This is the second of three related articles presenting the results of a research project supported by the Geography Branch of the Office of Naval Research. The first, "Delimiting the CBD," appeared in the July, 1954, issue of this magazine; the third and concluding article, "Internal Structure of the CBD," will be published in the January, 1955, number. For acknowledgments of assistance see the first article. When the series is completed, it is planned to make the three articles available under separate cover, with a bibliography, and with an appendix giving land use data in detail.

[1] Raymond E. Murphy and J. E. Vance, Jr.: "Delimiting the CBD," *Econ. Geog.*, Vol. 30, 1954, pp. 189–222.

as typically central business in character and others that were non-central business; and indexes for deciding whether a block was or was not to be included in the CBD were developed and used, together with certain rules.

TABLE I

CBD DATA RESULTING FROM FIELD MAPPING

	Grand Rapids	*Mobile*	*Phoenix*	*Roanoke*	*Sacramento*	*Salt Lake City*	*Tacoma*	*Tulsa*	*Worcester*	*Average*
Gross area of CBD (acres)	97.3	73.0	126.7	77.4	188.2	189.4	67.8	136.3	87.1	115.9
Ground floor area (acres)	58.9	50.4	76.8	53.3	108.8	120.8	52.4	79.8	59.6	73.4
Total height index	3.320	2.124	1.806	2.337	2.009	2.114	2.336	3.154	2.964	2.422
Central Business Height Index	2.4	1.5	1.5	1.9	1.5	1.5	1.9	2.6	2.0	1.8
Central Business Intensity Index	72.9	70.5	82.0	82.8	73.1	73.0	80.5	82.5	67.9	76.0
Total floor space in CBD (acres)	195.5	107.1	138.8	124.5	228.4	255.4	122.4	251.8	176.7	177.8
Central business floor space in CBD (acres)	142.5	75.5	113.8	103.1	167.0	186.4	98.6	207.7	120.0	135.0
Average block size (acres)	1.73	2.02	2.13	1.72	2.13	6.71	1.59	1.86	2.13	2.45
Gross land area of CBD as percentage of area of incorporated city	.65	.45	1.16	.46	1.74	.55	.22	.80	.37	.71
Gross land area of CBD as percentage of area of urbanized area	.33	.28	.36	.35	.71	.40	.17	.56	.31	.39

TABLE II

BACKGROUND DATA FOR THE NINE CITIES

	Grand Rapids	*Mobile*	*Phoenix*	*Roanoke*	*Sacramento*	*Salt Lake City*	*Tacoma*	*Tulsa*	*Worcester*	*Average*
Incorporated city, area in sq. mi. (1950)	23.4	25.4	17.1	26.5	16.9	53.9	47.9	26.7	37.0	30.5
Incorporated city, population in thousands (1950)	177	129	107	92	138	182	144	183	203	151
Urbanized area, area in sq. mi. (1950)	46.7	41.0	55.1	34.7	41.6	76.1	62.2	37.7	43.6	48.7
Urbanized area, population in thousands (1950)	227	183	216	107	212	227	168	206	219	196
Percentage of urbanized area population inside central city	77.9	70.3	49.2	86.0	64.6	80.1	85.7	88.5	92.7	77.2
S.M.A., area in sq. mi. (1950)	862	1,248	9,226	303	985	764	1,676	572	286	1,769
S.M.A., population in thousands (1950)	288	231	332	133	277	275	276	252	276	260
Curtis market area, area in sq. mi.	6,083	9,121	19,354	7,226	9,146	91,586	6,209	7,301	1,516	17,505
Curtis market area, population in thousands (1950)	551	421	399	421	467	568	455	414	546	471
Wholesale trade of urbanized area, employees (1950)	4,715	2,780	4,717	1,951	4,651	6,205	2,268	5,349	2,976	3,957
Retail trade of urbanized area, employees (1950)	15,376	11,348	16,012	7,855	15,716	17,185	11,467	18,613	13,936	14,167
Clerical and kindred workers in urbanized area (1950)	13,009	9,087	10,687	6,758	18,208	15,248	8,263	16,019	12,849	12,243
Sales workers in urbanized area (1950)	8,956	4,589	7,261	4,223	7,604	8,868	5,198	8,281	6,824	6,867
Wholesale trade of incorporated city, employees (1950)	3,725	2,249	2,592	1,786	3,226	5,179	1,967	4,498	2,777	3,111
Retail trade of incorporated city, employees (1950)	12,517	8,674	8,788	6,989	11,296	14,225	10,084	15,216	8,219	10,668
Clerical and kindred workers in incorporated city (1950)	10,917	7,502	6,834	5,982	13,927	13,202	7,380	14,911	11,994	10,294
Sales workers in incorporated city (1950)	7,234	3,556	4,209	3,734	5,446	7,513	4,487	7,663	6,351	5,577

Sources: Curtis Market Areas after *Market Areas in the United States*, The Curtis Publishing Company, Philadelphia, 1952. All other data based on U. S. Census.

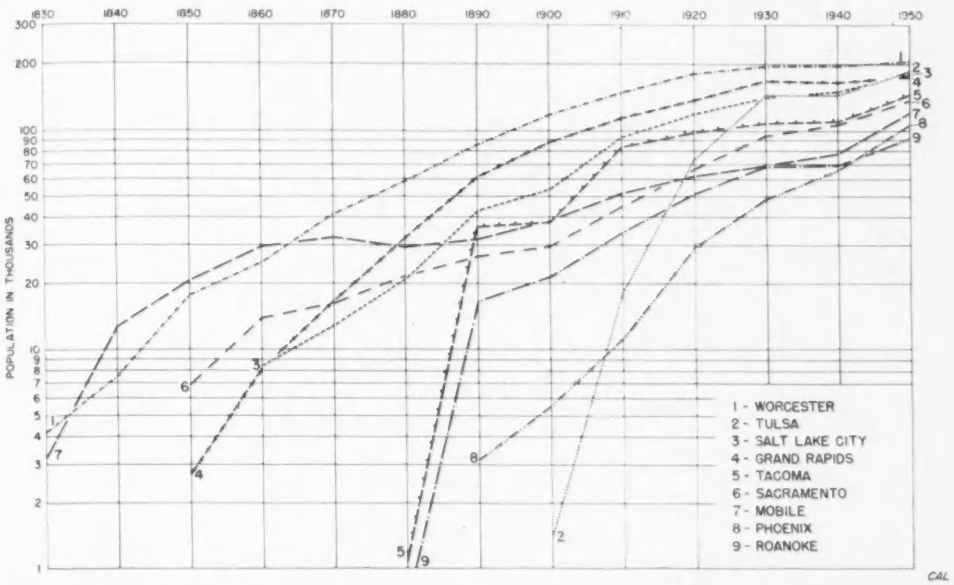

Fig. 1. Population curves for the nine cities. Mobile and Worcester are the oldest cities; Phoenix, Tulsa, and Roanoke are the youngest. Note the way in which Mobile's curve levels off in the latter part of the 19th century and then begins to rise again. Note, also, the phenomenal growth of Tulsa between 1900 and 1930.

Objectives

The comparison of CBDs in their total aspects, which is the subject of this paper, has broader objectives than a mere determination of facts. Throughout the article, an attempt is made to reach justifiable generalizations, keeping in mind the fact that only nine cities were studied and that the range in size was small (Table II). Various problems emerge: To what factors does the size of the CBD appear to be related? Does the District have a typical shape? Why are some CBDs centrally located in their urban areas and others not? What land use proportions are typical for the Districts of cities of the size studied? How do the CBDs vary with the economic specialization of the city? How do the CBDs of the older cities of the East differ from those of the newer cities of the West? The major purpose of the comparisons is to arrive at answers to questions such as these.

The City and the CBD

Before beginning a systematic study of CBD characteristics, it is well to have a general view of each city in its regional and local setting. The purpose of this section is to present in brief form the character of each CBD and the background for its development.

Worcester

Worcester, Massachusetts, is old, and the incorporated city has the largest population total of any of the nine cities considered in this study (Fig. 1). It is an industrial center, set in a region of closely spaced urban communities. Boston lies only 45 miles to the east, and Providence the same distance to the south. New York City is only 150 miles to the southwest, and the intervening space is well served by a number of competing cities such as Springfield, Hartford, and New Haven. These facts help to explain the character of Worcester's CBD.

Worcester's site, in the midst of rough terrain, was probably the best possible one for city development between Boston and the Connecticut Valley. The city is located in a hilly region, where the headwaters of the southward flowing Blackstone River etched out a knobby, lozenge-shaped basin (Fig. 3). The basin is elongated in a north-south direction, being about five miles long as opposed to two miles wide.

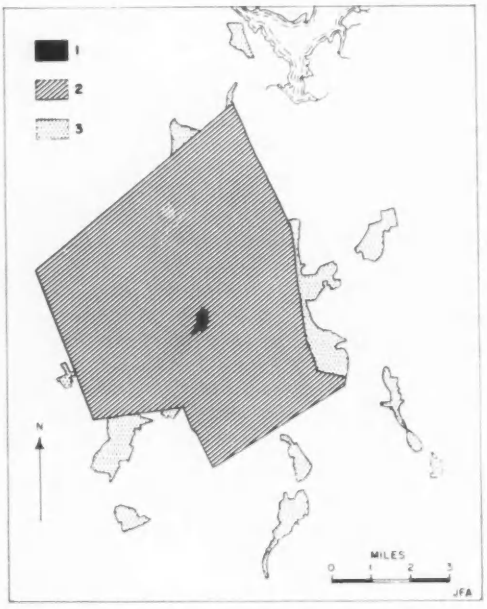

FIG. 2. Worcester's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

During late colonial times the Upper Boston Post Road passed through the Worcester area en route to New York City, and its course can readily be traced in the main axis of the city of today. The Post Road passed north of Lake Quinsigamond and, crossing the hilly area just to the west, dropped into the northern end of the Worcester basin near Lincoln Square. From this point the road, now called Main Street, took a south-southwesterly course along the basin floor. Finally, after traversing the lowland for more than three and a half miles, the road climbed its western edge. Worcester's CBD extends for nearly a mile along this route, skirting the hills on the western edge of the basin.

In 1808 a more direct, toll road, known as the Worcester Turnpike, was laid out between Worcester and Boston. The Turnpike crossed Lake Quinsigamond from the east and took a straight course over rather steep hills to converge with the Post Road at Lincoln Square. Here, the first nucleus of urban development appeared, well outside the present CBD.

In the meantime, New England was becoming industrial and Worcester along with it. New methods of transportation appeared. The Blackstone Canal, linking Worcester to Providence, was completed in 1828, with its terminus at Lincoln Square. In 1835 the Boston and Worcester Railroad was built, with its terminus more than half a mile farther south. The canal was abandoned soon after railroads came to the city. These improvements were financed by Worcester industrialists. Industry combined with good transportation to promote the city's development.

For three-quarters of a century the city of Worcester, like near-by American cities, was dominated by its railroads. Worcester industrialists built their factories along them, and the present location of the CBD reflects the attraction of the railroad terminus. Today, the peak land value intersection lies about half a mile south of Lincoln Square on Main Street, almost due west of the Union Station.[2]

Although Worcester's railroads have

[2] For the location of the peak value intersection in each city and for the details of street patterns see Murphy and Vance, *op. cit.*, Figs. 6–14, pp. 210–218.

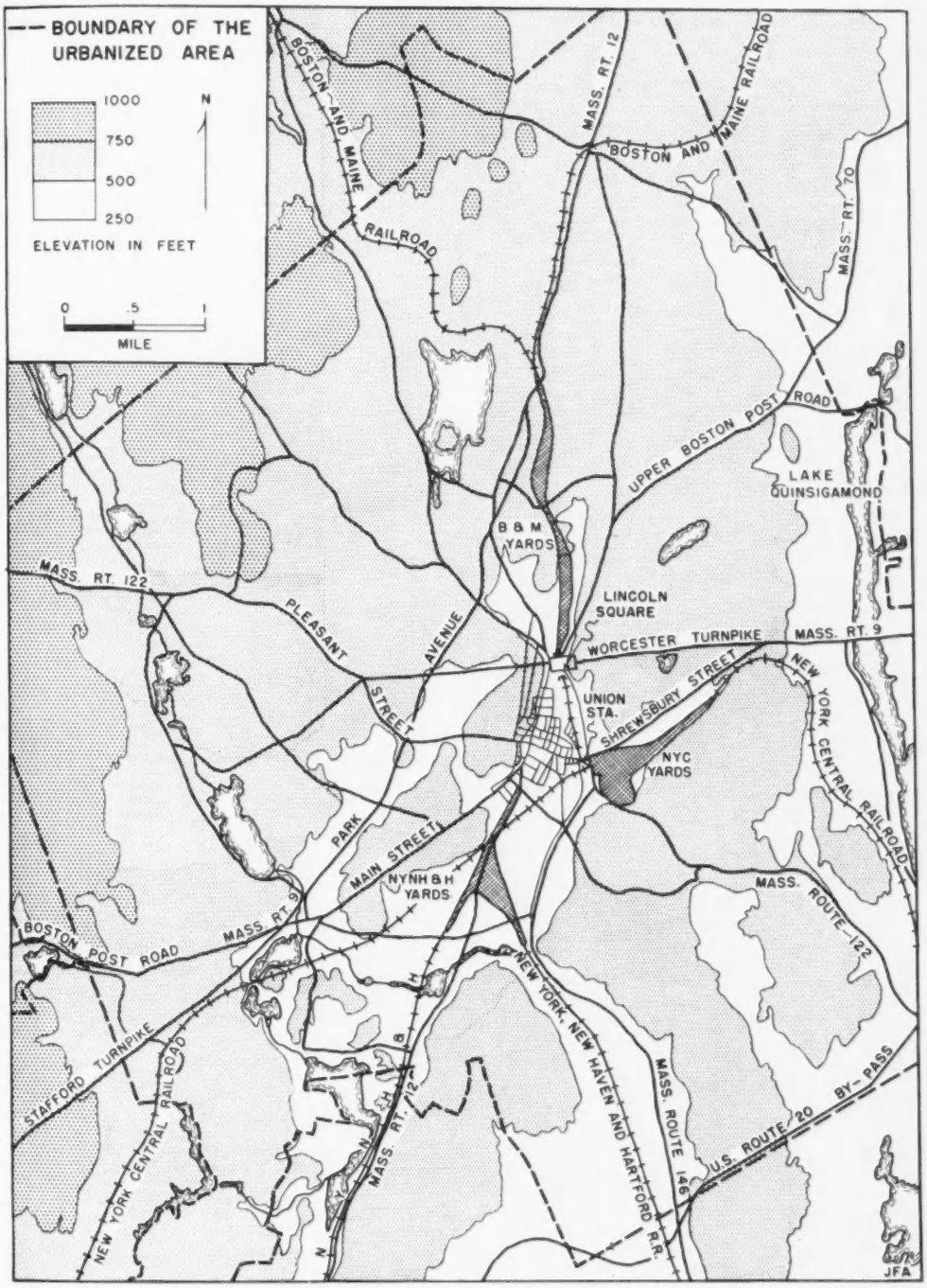

Fig. 3. Although Worcester's CBD lies in a lowland, the city sprawls over surrounding hills and valleys alike. Compare with Figure 2.

affected the location of its CBD, there is only one spot where the present CBD comes into actual contact with the railroad, and there it is only a spur track. Elsewhere, a cushion of other uses always keeps them apart. Perhaps this is to be expected in an industrial city where railroad frontage is more important for manufacturing sites than for CBD usage. In Worcester, wholesale houses and factories compete for space near the railroad.

The railroads describe a great sweeping barrier a few blocks to the east of Worcester's CBD, but expansion of the District has been restricted in other ways as well. Hills, which rise a hundred or more feet above the basin floor, lie within a block or so of Main Street toward the west. In places the slopes are steep, and commercial uses have lapped up on no more than the lower portions of the hills. In a few localities, however, commercial development has actually progressed well up the slope in spite of the obstacle of difficult terrain.

Worcester's CBD is small in area, ranking sixth among the nine cities (Table I). Undoubtedly, this is due in part to the presence of barriers that have impeded its expansion (Fig. 23), but there are other reasons for its limited area. It may be that an industrial city does not require as large a CBD as do cities devoted primarily to commercial pursuits. It must be remembered, too, that Worcester's CBD took form a long time ago. Because, at that time, mass transportation had to be depended upon, people placed a premium upon close association of as many urban functions as possible at the center of a city.

There is another reason for Worcester's CBD being small. Not only is the city overshadowed to some extent by Boston and even New York, but it is located in a region of thick-set urban development. Numerous cities, large and small, serve the commercial needs of the people. In New England, shopping is more likely to be a matter of "going down town" than of "going to town" as it is elsewhere in the United States.

The presence of so many competing cities accounts for the small size of Worcester's market area. According to a recent delimitation of retail market areas by the Curtis Publishing Company,[3] the region dominated by Worcester is far smaller than the market area of any other of the nine cities (Fig. 4 and Table II). It is significant, however, that this market area is far more densely peopled than any of the others.

Worcester's CBD has been described as small in area. On the other hand, it has a greater average height of buildings than most of the other CBDs studied in this group (Table I). Worcester's CBD is not as high as Tulsa's or that of Grand Rapids, but there is a definite clustering of four- and five-story buildings close to the center of the area, and the general average for the whole CBD is nearly three stories. A small, but high, CBD is not an unreasonable expectation for an old industrial city like Worcester.

What is surprising is the city's low Central Business Intensity Index (Table I). Worcester's index of 67.9 per cent puts the city at the bottom of the list. A partial explanation may be found in the large, irregularly shaped blocks. Sometimes a block fronts on a major business street but extends back into areas of industrial or residential development. Probably more important is the factor of tradition. Worcester is a 19th century city, and in such cities commercial, industrial, and residential land uses are likely to share the space near the center.

[3] *Market Areas of the United States*, Curtis Publishing Company, Philadelphia, 1952.

Grand Rapids

In several respects Grand Rapids is similar to Worcester, though of course different factors contributed to its development. Like Worcester, Grand Rapids is an old city as American cities go (Fig. 1). It was located at rapids in the Grand River as a sawmill site in 1831 and reached its greatest period of urban growth shortly before the turn of the century. Like Worcester, it is an industrial city, but Worcester specializes in metal products and Grand Rapids' specialty is furniture. Like Worcester, too, Grand Rapids is primarily a product of the railroad age.

An interesting contrast between the two cities results from the fact that Grand Rapids lies in an area of Congressional townships, a system of land division that was not in use until late in the 18th century. This survey system is characterized by north-south and east-west boundary lines, which explains the orientation of much of the boundary of Grand Rapids' CBD as well as the courses of many of the District's streets (Fig. 5). Worcester, on the other hand, was laid out in a region where metes and bounds surveying and irregularly shaped towns were used. Hence, that city lacks any orientation to the cardinal compass directions.

However, the pattern of Grand Rapids' CBD is not altogether one of north-south and east-west lines. In part of the CBD a notably different orientation of the streets prevails. An explanation of this contrast lies in the fact that two rival promoters laid out plats, one to the north and the other to the south. The promoter who laid out the streets

Fig. 4. Curtis Market Areas for the nine cities. Numbers refer to market areas as follows: 1, Worcester; 2, Grand Rapids; 3, Salt Lake City; 4, Tacoma; 5, Sacramento; 6, Phoenix; 7, Tulsa; 8, Mobile; 9, Roanoke. The small size of Worcester's market area reflects the competition of adjacent cities as well as the density of population of southern New England. The vast extent of the Salt Lake City market area results from just the opposite conditions. Salt Lake City is in a sparsely populated, dry area, with the nearest large competing centers hundreds of miles away. The area and population of each of the market areas is given in Table II. (Extent of market areas from *Market Areas of the United States*, Curtis Publishing Company, Philadelphia, 1952.)

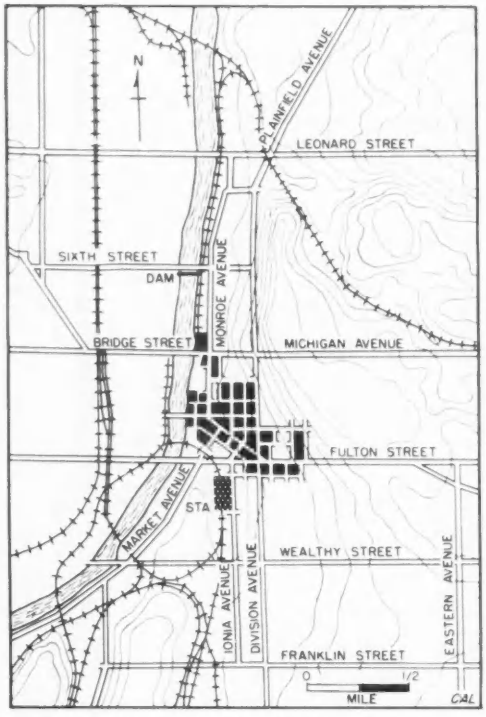

FIG. 5. Grand Rapids' CBD, represented on the map by the filled-in blocks, lies between the Grand River and a belt of hills. Expansion of the city westward, across the river, and eastward, up the slope, has left the district in a fairly central position in the city. Compare with Figure 6. (Contour Interval: 20 feet.)

of the more southerly plat used a grid pattern, but deliberately planned it with northwest-southeast and northeast-southwest streets so it would not conform with the grid to the north. It is one of these diagonal streets, Monroe Avenue, that forms the heart of the present CBD. On this street the peak land value intersection occurs, and along this street are the city's tallest buildings.

Grand Rapids' CBD, like those of many other cities, has been impeded in its development by the presence of barriers (Fig. 23). First, there is the Grand River, with a belt of old factories along its eastern bank. Then, there is a knot of railroad lines, rail yards, and a union station directly south of the main part of the CBD. Another barrier, one that has had much to do with the CBD's outline, is the mass of hill land northeast of the peak value intersection. The CBD lies on the Grand River flood plain, between the hills and the river, an area of relatively level land that narrows toward the north. This plain allowed the District to spread eastward in its southern reaches, but has restricted it considerably in the north. Barriers, plus the presence of diagonal streets, explain the arc-like outline of Grand Rapids' CBD. The extreme irregularity of the outline, on the other hand, is probably due to overzealous commercial expansion in the past.

The lack of serious barriers toward the southeast helps to explain the fact that the CBD is shifting and intensifying in that direction. This shift is particularly well demonstrated by the

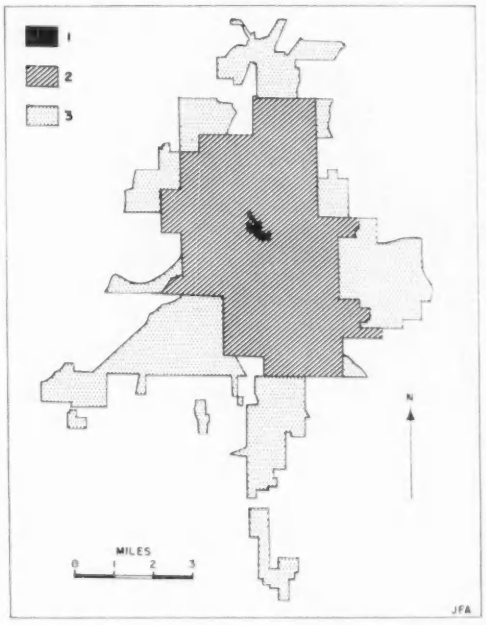

FIG. 6. Grand Rapids' CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1, CBD as delimited in first article of this series; 2, remainder of incorporated city; 3, urbanized area extensions beyond incorporated city.

city's largest department store, which has moved into new quarters a block farther southeast. Its former quarters have been taken over by a second store that was previously located four blocks to the north and west.

Sharp contrasts exist between most eastern and western cities in the matter of area of the Central Business District. This measure alone would classify Grand Rapids as an eastern city. Its CBD is only one-half to two-thirds as large as the CBDs of such western cities as Sacramento, Salt Lake City, Phoenix, and Tulsa. At least part of the explanation for the limited areal extent of Grand Rapids' CBD lies in the fact that its average height, 3.32 stories, is greater than that of any of the other eight CBDs. But the District's Central Business Intensity Index is low, reflecting the use of space for wholesaling and the existence of considerable vacancy, the latter resulting from over-expansion of the District in an earlier period.

Although Grand Rapids is predominantly a manufacturing city, it has the reputation, too, of being a regional trade center. Its tributary area (Curtis Market Area) is about 6000 square miles, which is not large as compared with those of western cities, but, in total population, the market area ranks second only to Salt Lake City's (Table II and Fig. 4). Moreover, Grand Rapids is above the average of the nine cities in number of both retail and wholesale trade employees in its urbanized area.

Salt Lake City

Salt Lake City, the capital of Utah, the wholesaling center for a vast area in western United States, and the administrative center for the Latter-Day Saints' church, has a CBD commensurate with its regional importance. It is a large, low, open area, composed of 10-acre blocks. As might be expected, the Central Business Intensity Index of the CBD is low, and many non-commercial uses appear within the District.

Salt Lake City was laid out in 1847 on a gently sloping area of coalescing alluvial fans at the base of the Wasatch Mountains (Fig. 8). There was ample space, and the church authorities laid out a city with generous gardens, and streets adequate for turning farm teams. From the first, Salt Lake City was planned, not as a possible city, but as an actual city. The tradition of the Latter-Day Saints' church called for residence in towns and the focusing of these towns upon a metropolitan city. The original concept of the city was so vast that only recently has it become necessary to expand into newly platted land.

In a sense, Salt Lake City was planned from the beginning for what it has become. Far-sighted as the planners were, they could hardly be expected to foresee the urban development of the automobile age. Fortunately, the streets were wide to begin with (132 feet), so Salt Lake City has been spared much of the expense of adjusting itself to automotive travel. But the gigantic blocks, originally planned to contain a few houses with their associated gardens, have lent themselves oddly to the uses of a CBD. In many blocks the façade of high value business buildings hides an interior given over to non-CBD uses such as manufacturing, power generation, residence, and the accumulation of waste. The city's CBD is composed of a series of hollow squares when considered from the point of view of commercial land use. This situation helps to explain the low Central Business Intensity Index of Salt Lake City (73.0) as well as the fact that its CBD has the largest area of any city studied (Table I).

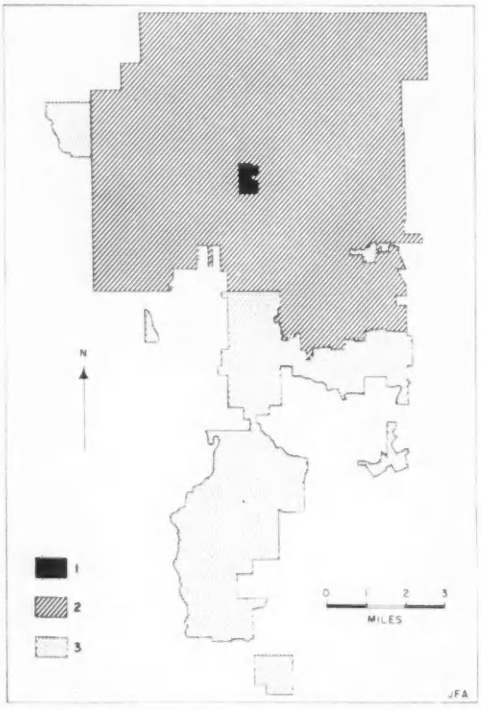

FIG. 7. Salt Lake City's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

Salt Lake City's CBD is almost wholly without barriers (Fig. 23). Although the Wasatch Mountains are present, nowhere, except in the north where the North Bench lies adjacent to the blocks occupied by the church buildings, do the mountains approach the CBD closely enough to block expansion. The CBD has been particularly free to move southward along Main Street. The movement in this direction has been accentuated by the location of Gentile (non-Mormon) business establishments well to the south of the Mormon business area, which is located near the church center. As a result, Salt Lake City is almost bi-polar in its CBD, with a Mormon pole in the north near the Temple Block and a Gentile pole farther south near and beyond Third South Street. The present peak value intersection lies between these poles, and the CBD has an elongated shape rather than an equidimensional one.

The Wasatch Oasis is the immediate market area for Salt Lake City. Because it depends upon irrigation from mountain streams, it is extremely linear, conforming to the straight, north-south Wasatch Front. It is divided into two parts by a transverse spur of the Wasatch Mountains, which lies just to the north of the CBD. The District is centrally located as far as the whole oasis goes, but since the built-up area has expanded almost entirely to the south, the CBD is off center for the city, itself (Fig. 7).

Beyond the Wasatch Oasis, Salt Lake City draws upon an open mesh of settlement in parts of northeastern Nevada and southwestern Wyoming as well as most of the State of Utah. This vast area has a sparse but mobile population. Worcester and Tacoma may lose out to larger near-by neighbors, but Salt Lake City has no rivals within 500 miles in any direction. This helps to explain why it is an important wholesaling center.

Another feature that makes the city a wholesale center is the absence of many large, diversified settlements in the intermontane West. There are agricultural towns (largely Mormon), mining towns, ranches, and lumber camps, but each of these serves a specialized function and lacks a broad economic base with a well-developed wholesale and retail trade. For this reason, Salt Lake City dominates the Great Basin to a much greater degree than most trade centers dominate their tributary regions.

Strangely enough, the city has only recently acquired adequate railroad connections. The route of the Union

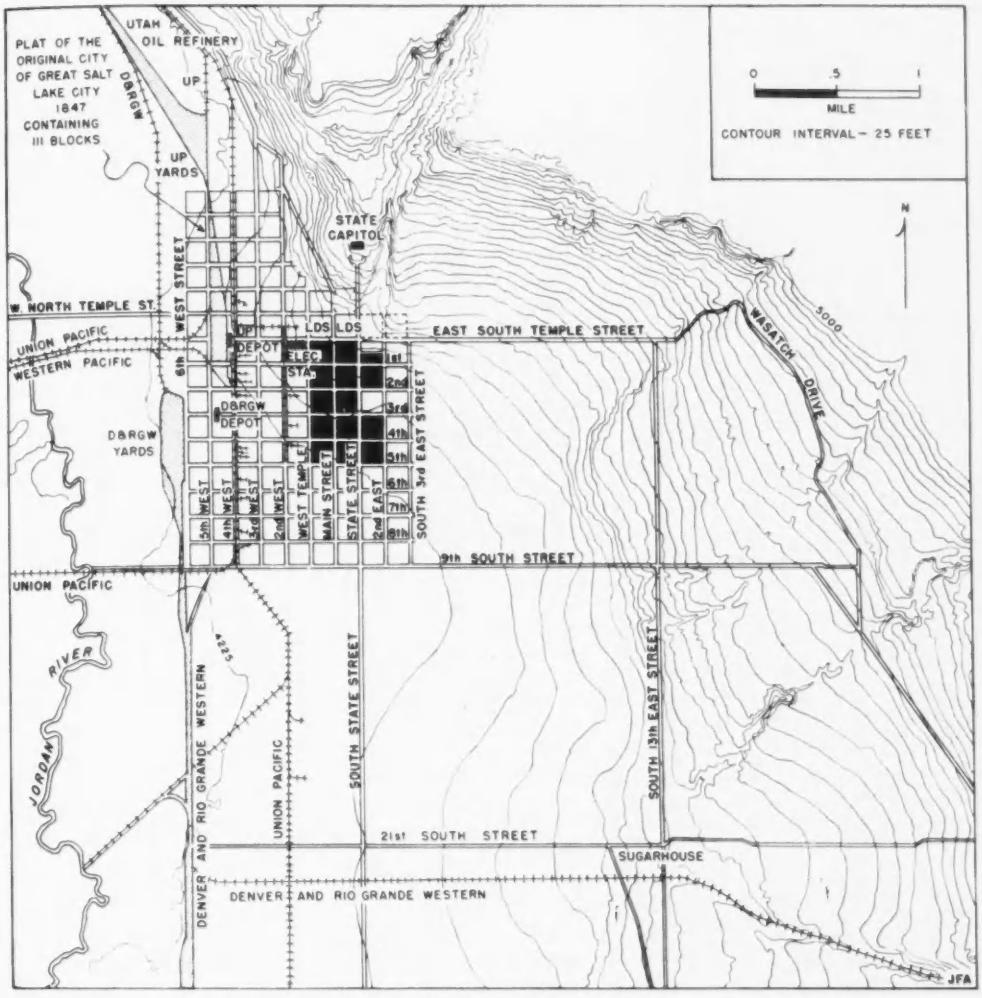

Fig. 8. Salt Lake City's CBD is oriented according to the cardinal points of the compass in a region where the Congressional township survey system prevails. Nevertheless, the city's orientation is not related to the survey system, since Salt Lake City was established before the region had been surveyed according to the Congressional township system. The area divided into blocks on the map is that of the original plat of Great Salt Lake City. Elsewhere, only major arterial streets are shown. CBD blocks are in black. The letters "LDS" mark the Mormon church blocks, one of which contains the Temple. Compare with Figure 7.

Pacific–Southern Pacific line between San Francisco and Chicago was opened through Ogden in 1869. Later, the Union Pacific continued its line southward through Salt Lake City to Los Angeles. However, this transcontinental route was relatively unimportant before the recent burgeoning of Southern California. This Los Angeles to Chicago line gave the city its first truly transcontinental route. Recently, the Denver and Rio Grande Western and the Western Pacific have joined in the formation of an additional transcontinental route passing through Salt Lake City. Thus, Salt Lake City offers the paradox of an American city becoming increasingly railroad oriented in the automobile

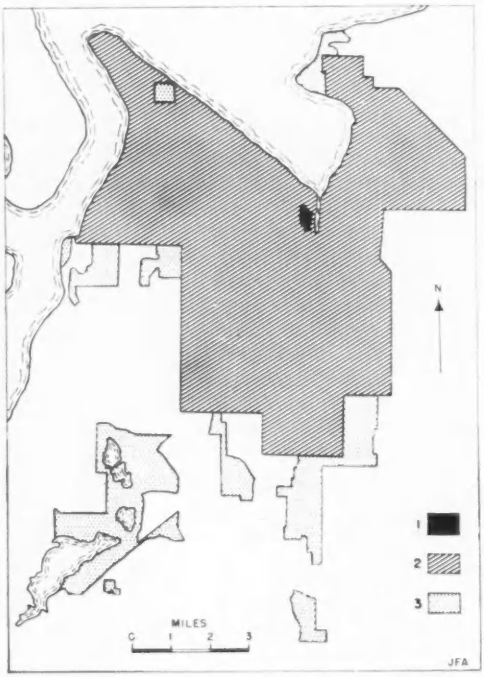

FIG. 9. Tacoma's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

age. In a very real sense, though, the railroads came to the city. The city was not the creation of the railroad.[4]

Tacoma

In the late 19th century, Tacoma became the major port of the Puget Sound area. It had decided assets. The young city was located on the deep water of Commencement Bay; it became the first rail terminus on the Sound; and the great lumber industry of the Pacific Northwest was getting under way. But Tacoma's assets proved to be short-lived. Seattle, only 35 miles to the north along the Sound, acquired equally good, or even better, rail connections with the East, and the northern city quickly outgrew its southern rival. Furthermore, the great timber resources, which had fed Tacoma's sawmills and wood-working industries, were soon nearly exhausted. The city stagnated, growing old long before its time.

Though the peninsula on which the city is built is on the whole gently rolling, it has a steep shore along Commencement Bay (Fig. 10). On this steep face, the embryo city, the present CBD, was laid out in regular, rectangular blocks. Both the District, and the blocks which comprise it, are elongated in a roughly north-south direction, nearly parallel to the water front. The whole CBD slopes sharply to the northeast, dropping as much as 150 feet between its western and eastern edges. The north-south streets are fairly level, but the cross streets plunge down steep slopes, dropping as much as two stories in a single block.

Fitting a business district to such a site has resulted in an interesting and unusual CBD. Tacoma has a smaller and slightly higher CBD than the other western cities studied here, both of which facts may be due to steep slopes and the attendant difficulties of spreading the CBD widely in such a situation.

The odd, bench-like appearance of the CBD, like a steep section of bleachers, results in a peculiar piling up of retail establishments. The stores on lower streets often extend completely under stores on the streets above. This doubling of available ground-floor retail space gives Tacoma the highest proportion of space devoted to retailing of any city studied (Fig. 25). That, at the same time, the city's CBD has a high proportion of vacancy, may indicate that Tacoma's retail space is actually greater than it needs. All this is accentuated by the small block size found in Tacoma's CBD, the smallest of

[4] For a more detailed consideration of Salt Lake City see Chauncy D. Harris: *Salt Lake City, A Regional Capitol*, Private Edition, University of Chicago Libraries, Chicago, 1940.

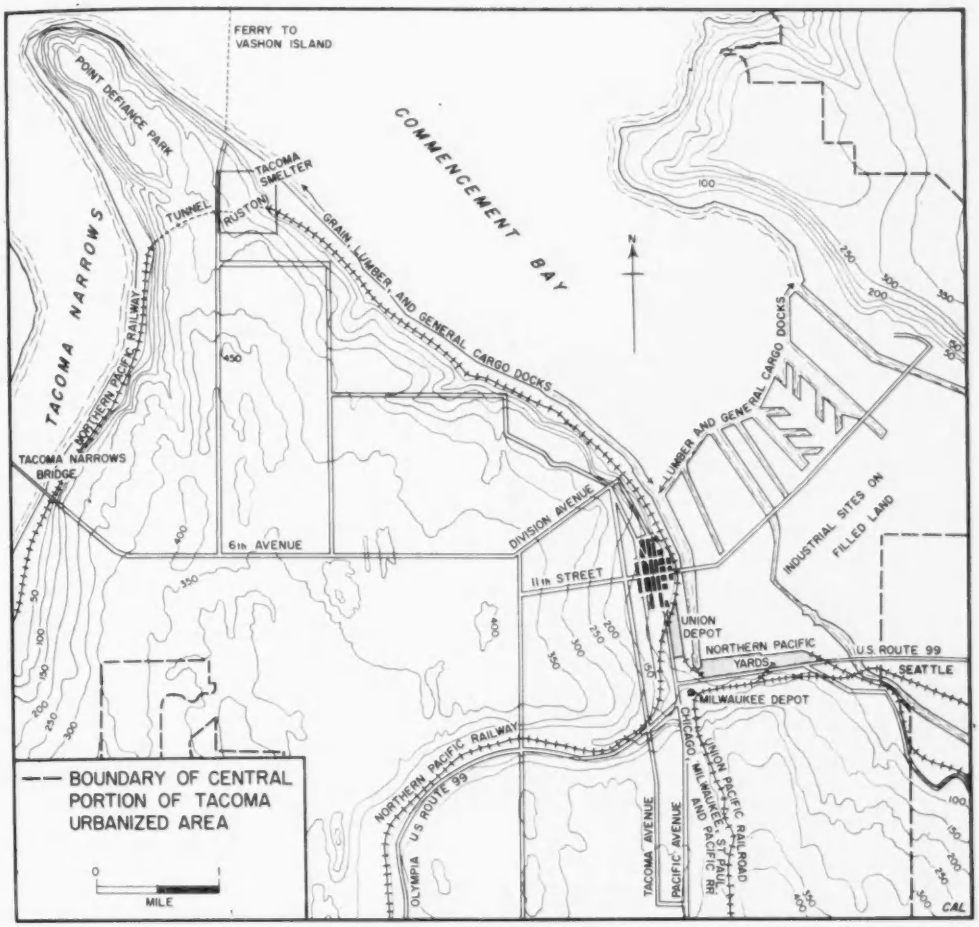

Fig. 10. Tacoma's CBD is the only one of the nine that has a steeply sloping site. It is not surprising, therefore, that the District has developed with its long direction parallel to the water front instead of developing at right angles to it, which seems to be more normal in port cities. Elevations in feet. Compare with Figure 9.

any of the nine CBDs. Small blocks give a CBD a high proportion of street frontage, though in Tacoma only the bench streets are intensively used. The cross streets are often too steep to attract much use.

Since Tacoma's CBD is located on slopes that would prove too steep for most cities, slope as a barrier must be discounted here. Only in one place, where there is a sheer drop of 40 feet, is there a barrier that can definitely be attributed to slope. But the straight western boundary of the CBD may be due to slope indirectly. Steepness of the cross streets makes expansion up the slope difficult, and when once it has been achieved there is a tendency to utilize the bench street fully before going up to the next level.

Nevertheless, Tacoma's CBD has expanded up the slope. It was originally centered on Pacific Avenue, two blocks nearer the water front than the location of the present peak value intersection. But Pacific Avenue, though easily reached from the port and railroad terminals, was hard to reach from the residential districts farther out the peninsula. Consequently, the CBD has

moved up the slope, now centering on Broadway. Its original location on Pacific Avenue has been virtually abandoned.

As is the case with other port cities, Tacoma's CBD is located off center with respect to the urban area as a whole (Fig. 9). Most of the city lies to the west and north. Unlike the situation in most port cities, though, Tacoma's CBD axis parallels the water front. This is no doubt due to two factors, steep slopes, which tend to encourage the elongation of the bench streets, and the general orientation of the shore upon which the District is built.

Because Seattle effectively competes with Tacoma to the north, the city's trade area lies largely to the south and west (Fig. 4). Also, Tacoma still has better connections with the Kitsap peninsula than has Seattle. Tacoma has a bridge across the intervening narrows, whereas at present Seattle must reach the peninsula by way of a ferry. This means that Tacoma is as asymmetrically located within its trade area as the city's CBD is within its urban area.

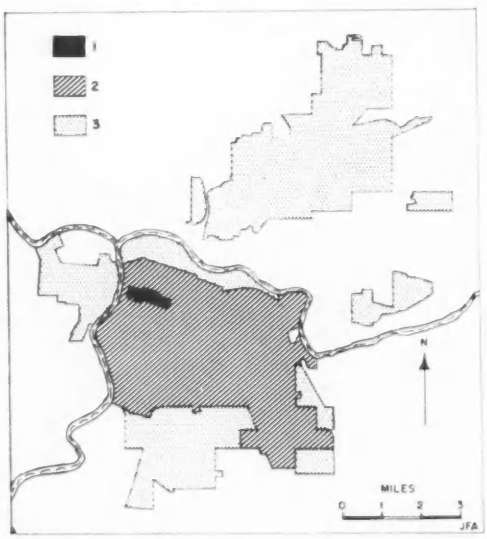

FIG. 11. Sacramento's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

Sacramento

Sacramento, the capital of California, is located in the broad Central Valley 35 miles north of the coalescing deltas of the San Joaquin and Sacramento Rivers. Here the floodplain is no more than 20 feet above sea level. Relief is always relative, and in Sacramento a rise of ten feet is sufficient to create a "hill." On such a hill, John Sutter established his fort in 1839. The first road in the vicinity connected the fort with Sutter's landing, on the Sacramento River a short distance below its junction with the American River. A village grew up near the landing, and this nucleus expanded out along the road which has become known as K Street, the major business street of the city.

On so flat a site, relief is no barrier to the expansion of a CBD. But the rivers with their extensive flood plains and the danger of floods have made effective barriers to the north and west. Sacramento's CBD has other barriers, too (Fig. 23). The presence of a group of government buildings associated with the capitol building and its park makes a seven-block barrier along the southern edge of the District. With barriers of one kind or another in the north, west, and south, the CBD has been particularly free to expand eastward, resulting in an elongated District which seems strangely out of place in so flat a scene.

This CBD, 14 blocks long, and only three or four blocks wide, has an interesting variation from west to east. The western part of the District contains the remnants of the early center along the river. Here one finds old, multi-

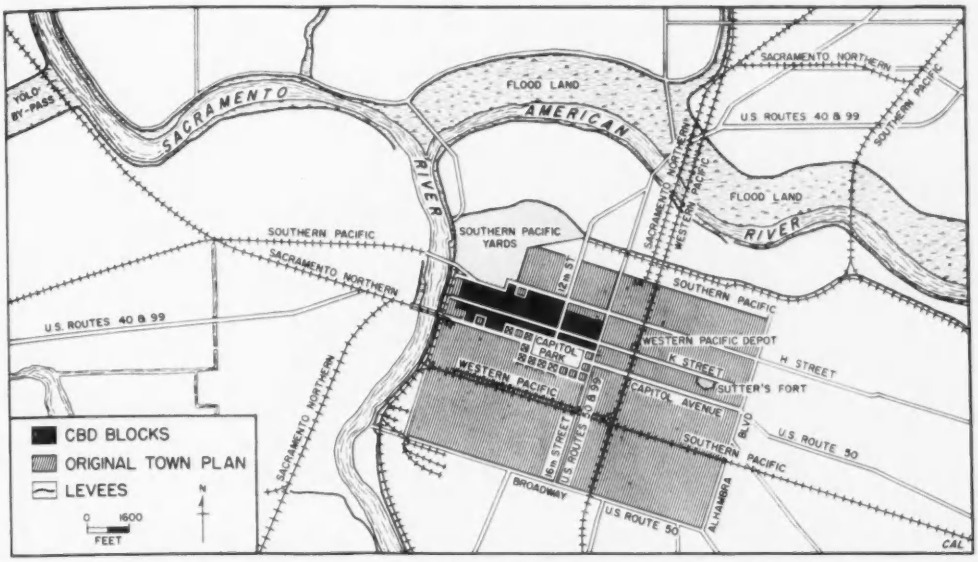

FIG. 12. Sacramento occupies a portion of the flood plain of the Sacramento River. Its CBD originated near the river but owes its present elongated shape to barriers which have prevented expansion except in an E-SE direction. Compare with Figure 11 and Figure 23.

storied buildings, now used for housing and particularly serving the needs of the large transient labor force which characterizes this part of California. In contrast, at the eastern edge of the District one finds an area of single-storied, relatively new buildings, erected during the automobile era and oriented toward serving motor-borne customers. Midway between these contrasting areas lies the core of the District, with its department stores, associated retail establishments, and the few tall office buildings of the city. The combination of these three rather distinct parts of Sacramento's CBD results in a District that is large, with relatively low buildings, a District whose intensity index is low for so young a city.

The non-central location of Sacramento's CBD with respect to its urbanized area is striking and can be explained by several factors (Fig. 11). In the first place, the city developed as a port, which always seems to work against a central position for a CBD. The low, marshy character of the Yolo flood-water by-pass to the west of the city discouraged growth of the urbanized area in that direction and so tended to leave the CBD off center. The growth of city toward the east may have been intensified somewhat by its close ties with the Mother Lode country in the foothills of the Sierras. Though the CBD has expanded eastward, too, it has not been able to keep pace with the eastward expansion of the urbanized area. This is brought out by the fact that there are several outlying shopping centers in this direction which compete with the CBD.

Although Sacramento is classed as a government center (Table III), this classification does not fully describe the economic support of the city. Basically, Sacramento is the major trade center for the whole Sacramento Valley, and it lies between this rich agricultural region and any possible rival, whether San Francisco or Stockton. The nine-county Curtis Market Area of 9146 square miles, the area most intimately tied to Sacramento, is the third largest

market area among the cities studied (Fig. 4). Sacramento's CBD is large, partly because the city is the State Capital and partly because the District is expanding rapidly eastward. But undoubtedly the considerable size of the CBD also reflects Sacramento's rich tributary region, which makes it one of the most dynamic cities of the United States.

Phoenix

Phoenix is a young city. It started as an agricultural settlement in 1864, and by 1870 the first extensive irrigation works were begun. With the completion of the large Salt River Valley project in 1911, the city developed as a regional trade center for a rich agricultural area. After serving as territorial capital, it became State Capital in 1912. Winter warmth that made agriculture productive as soon as water was supplied also made the valley attractive to tourists. After World War I, the population of Phoenix, together with its immediate vicinity, continued to grow rapidly, partly as a result of the rise of manufacturing (Fig. 1).

The site of Phoenix is flat and nearly featureless (Fig. 14). About five miles north of the CBD, and a similar distance to the south, steep ranges break the very gentle slope of the alluvial fans within the valley. However, near the center of the city no appreciable slope is found, and the Salt River, itself, is located about a mile and a half south of the CBD. Thus, natural barriers to the expansion of the CBD are absent. Only the tracks of the Southern Pacific Railroad, a block and a half south of the District, can be thought of as barring normal expansion.

With an open site on which to grow, and with the needs of the automobile era paramount, Phoenix's CBD has become almost a textbook example of a low Western city. The District is fairly large, exceeded in area only by the CBDs of Sacramento, Salt Lake City, and Tulsa, and it has the lowest average

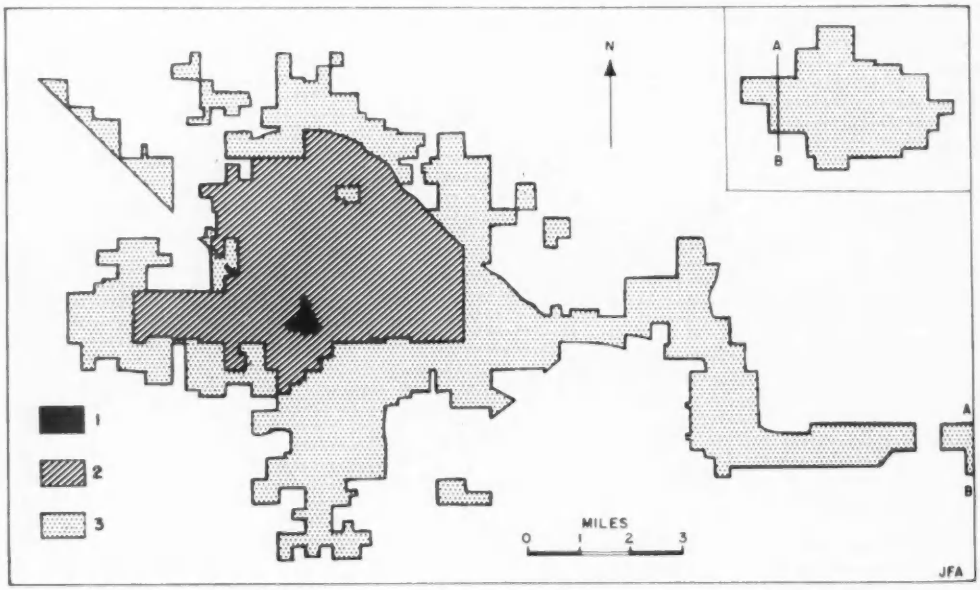

FIG. 13. Phoenix's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

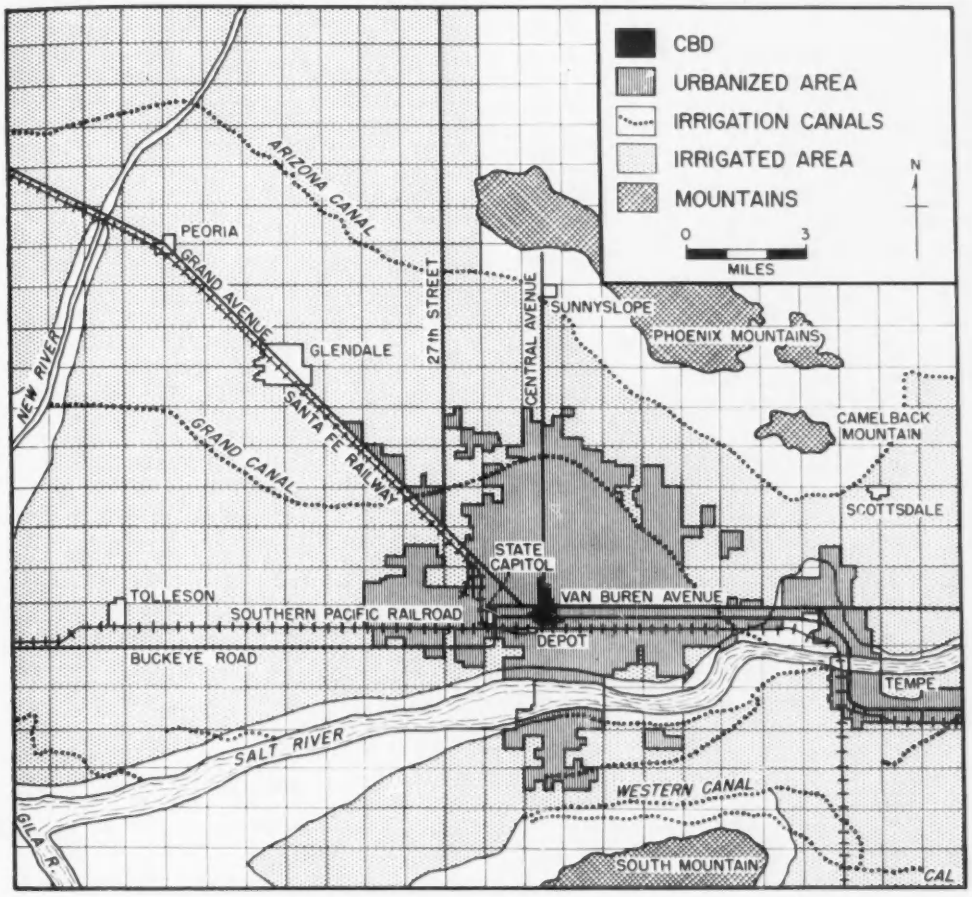

Fig. 14. Phoenix developed on the flats of the Salt River in a particularly good locality for serving the irrigated lands of the valley. The white areas on the map are unirrigated lowlands. The grid shown in the flat lowlands represents the sections of the Congressional township survey separated by section line roads. Compare with Figure 13.

building height of any of the CBDs (Table I).

Phoenix's recent urban growth has led to a neat segregation of uses within the city. Retail uses dominate the CBD with little of the admixture of industry, wholesaling, and residence characteristic of older, Eastern cities (Fig. 25). For this reason, the Phoenix CBD has an extremely high intensity index, higher than any other Western city studied except Tulsa.

Phoenix has a few moderately tall buildings. Since there is no serious lack of space, this vertical expansion may be explained more by the demands of local pride and the current desire for office space in tall, named buildings than by real necessity. This combination of low, generally single-story retail buildings and a few tall office buildings and hotels means that there are few two-, three-, and four-story buildings. In older cities, these are the buildings that tend to remain unused in their upper stories and thus increase the percentage of vacancy. Phoenix has very little vacancy in its CBD.

Phoenix is the only city studied whose CBD is laid out in complete conformity

with the Congressional township grid. The shape of the District reflects this adjustment very well. Its shape is somewhat like that of an isosceles triangle, with the base parallel to the railroad and the apex extended far to the north along the major axis of the District. That the CBD did not reach south along this axis is no doubt due to the reluctance that arises to extending a CBD across a railroad. The main east-west axis parallel to the railroad is well developed, giving the CBD almost as much length in this direction as it has north and south. The relatively uniform block size within the CBD makes such symmetry possible, particularly since the blocks are small—much smaller than those of Salt Lake City.

Though the railroad has curtailed the growth of the CBD to the south, rail transportation has not been as important to Phoenix as to most cities. Since the city in its early days was the capital of a thinly populated area, the main transcontinental line of the Southern Pacific was not shifted to Phoenix until as late as 1926. For this reason the automobile has played a large role in Phoenix and the CBD has been free to adjust itself to the needs of the automobile age.

Phoenix's trading area is large, but somewhat limited in population. Its Curtis Market Area, made up primarily of the irrigated oasis of the Salt River Valley and the adjacent mining country, is 19,000 square miles in extent (Fig. 4). However, due in part to its capital function and in part to the high mobility of the population, Phoenix can call the State of Arizona its tributary region. In fact, the nearest trade centers of competitive size are Los Angeles, nearly 400 miles to the west, and Albuquerque, a similar distance to the east. Salt Lake City is a difficult 500 miles to the north. Even the smaller cities such as Prescott and Tucson are more than a hundred miles away.

TABLE III

ECONOMIC CLASSIFICATION OF THE NINE CITIES

(After Victor Jones, "Economic Classification of Cities and Metropolitan Areas," Municipal Year Book, 1954, pp. 62–70 and Table IV)

	Symbol	*Classification*
Grand Rapids	Mm	Manufacturing
Mobile	Rm	Diversified, with retail trade predominant
Phoenix	Rr	Retail
Roanoke	Rm	Diversified, with retail trade predominant
Sacramento	G	Government center
Salt Lake City	W	Wholesale
Tacoma	Mr	Diversified, with manufacturing predominant
Tulsa	Rm	Diversified, with retail trade predominant
Worcester	Mm	Manufacturing

Mm—employment in manufactures 50 per cent or more of aggregate employment in manufactures, trade, and service establishments (excluding hotels and amusements), and employment in retail trade less than 30 per cent.
Rm—retail trade predominant and with employment in manufacturing more than 20 per cent but less than 50 per cent.
Rr—employment in retail trade greater than employment in any other category and employment in manufacturing less than 20 per cent.
G—15 per cent or more of labor force resident in city employed in governmental service.
W—number employed in wholesale trade at least 25 per cent of aggregate employment in manufacturing, trade, and service.
Mr—employment in manufacturing less than 50 per cent of the aggregate employment but greater than employment in retail trade.

Tulsa

Tulsa is young among the cities of this study. From a small village in 1900, it grew in half a century to a city of nearly 200,000 (Fig. 1). Salt Lake City and Sacramento are at least twice as old, and Worcester and Mobile are four or five times as old. Nevertheless, Tulsa is the most metropolitan of the cities studied and contains the most impressive CBD. Jutting up from the nearly featureless plain of northeastern Oklahoma, Tulsa's group of skyscrapers announces the city's importance long before the outlying residential areas have been reached.

Young as Tulsa is, it is a product of

the railroad age, for it was located where the Saint Louis and San Francisco (Frisco) Railway crossed the Arkansas River. In addition, the railroad accounts for the peculiar orientation of Tulsa's CBD, which does not conform to the normal Congressional township grid that blankets this area. Instead, the District stands at a right angle to the main line of the Frisco. The railroad gave Tulsa its first impetus and oriented its CBD, but it was the development of oil fields near by that caused the city's really phenomenal growth and created its core of high office buildings.

In a sense, Tulsa's CBD is an anachronism. Though Tulsa is located well to the west of the Mississippi River, its CBD, in being high in proportion to its area, is more like those of Worcester and Grand Rapids than like the CBD of a Western city. This is not what one would expect of a city that has grown up almost entirely in the automobile age. But, unlike the CBDs of Worcester and Grand Rapids, Tulsa's business district has a high Central Business Intensity Index (Table I). This seems to be characteristic of all the younger cities of this study. Tulsa has the highest and most modern buildings, the highest proportion of office space, and the least vacancy of any of the nine cities. This may be explained by the fact that Tulsa was built primarily as an office city, and, since it is only about half a century old, there is little obsolescence.

The city of Tulsa has spread easily to the north, east, and south, but it has been blocked to some extent from an equal spread to the west by the presence of the Arkansas River, the Frisco Railway, and a whole battery of oil refineries and storage tanks (Fig. 16). For this reason the CBD lies definitely off center in the city and in the urbanized area (Fig. 15). The CBD, itself, is bordered by the main line of the Frisco Railway in the north-northwest and by the Midland Valley Railroad in the east. These railroad barriers combine with slightly lower land in the west-southwest to funnel any extension of the District generally southward along Main Street and the parallel streets, Boston and Boulder Avenues. The fact that Main Street is very little more dominant than Boston Avenue as the chief axis of the CBD has led to the development of a District which, though elongated, is also rather broad.

The peak value point of the CBD has shown a definite tendency to migrate to the southeast. It started in the northwest at a junction of the main line of the Frisco Railway with a siding, at First and Main Streets, and has moved four blocks in the intervening years. It appears to be moving on toward the next intersection at the present time. In fact, the whole District seems to be growing in that direction and to be pulling away from its point of origin.

Tulsa, with its hundreds of offices associated with the oil industry, stands alone among the nine cities as an office city. For a number of years it has been a major headquarters center for all sorts of prospecting, refining, and sales operations within the Mid-Continent Oil Field. So many concerns engaged in these activities have central or regional offices in Tulsa that they account for 17 or 18 per cent of all the CBD space (Fig. 25). The petroleum industry and the services it requires undoubtedly go far toward explaining the presence of general offices, too, which require an equal amount of CBD space. All in all, offices account for more than one-third of Tulsa's CBD floor space.

Tulsa has more clerical workers and more retail trade employees than any other of the nine cities. Its market area, chiefly northeastern Oklahoma, is

FIG. 15. Tulsa's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

7000 square miles in extent (Fig. 4), but it is significant that half the population of the market area lies in Tulsa's urbanized area. This suggests that Tulsa is its own best customer. Apparently, the large employment in offices results in a large local retail market.

Mobile

Mobile Bay, a deep inlet in the Gulf Coast, ends at the north in a maze of marshy patches separated by wide but shallow indentations (Fig. 17). Only the bay's eastern and western shores provided suitable sites for port and city development, and the western shore was the better of the two, being somewhat lower and hence better for dock space and settlement than the eastern shore. Here, French colonists established a village as early as 1710, and the city of Mobile grew up on this spot.

Mobile is one of three ports considered in this study, and it is also the oldest of the cities studied. Although it achieved the stature of a small city early in the 19th century, it stagnated after the Civil War (Fig. 1). But, with the building of the Alabama State Docks, the city began a new period of progress, and it is still growing rapidly.

As a port, Mobile draws upon a large hinterland. It is Alabama's sole outlet to the sea, and the state is an important producer of heavy industrial products, lumber, and cotton. Much of this produce finds its way to Mobile by means of the Warrior-Tombigbee waterway, one of the major canal systems of the South. Because Mobile is so vital to the state's economy, large sums of money have been spent to give the city some of the most modern port facilities in the United States. But the port of Mobile draws upon a wider hinterland than Alabama, for north-south rail routes tie the industrial Middle West to the Gulf at this point.

Mobile is rapidly changing from its role as a minor Southern port to one of the nation's major seaports, and the city is developing industrially as well.

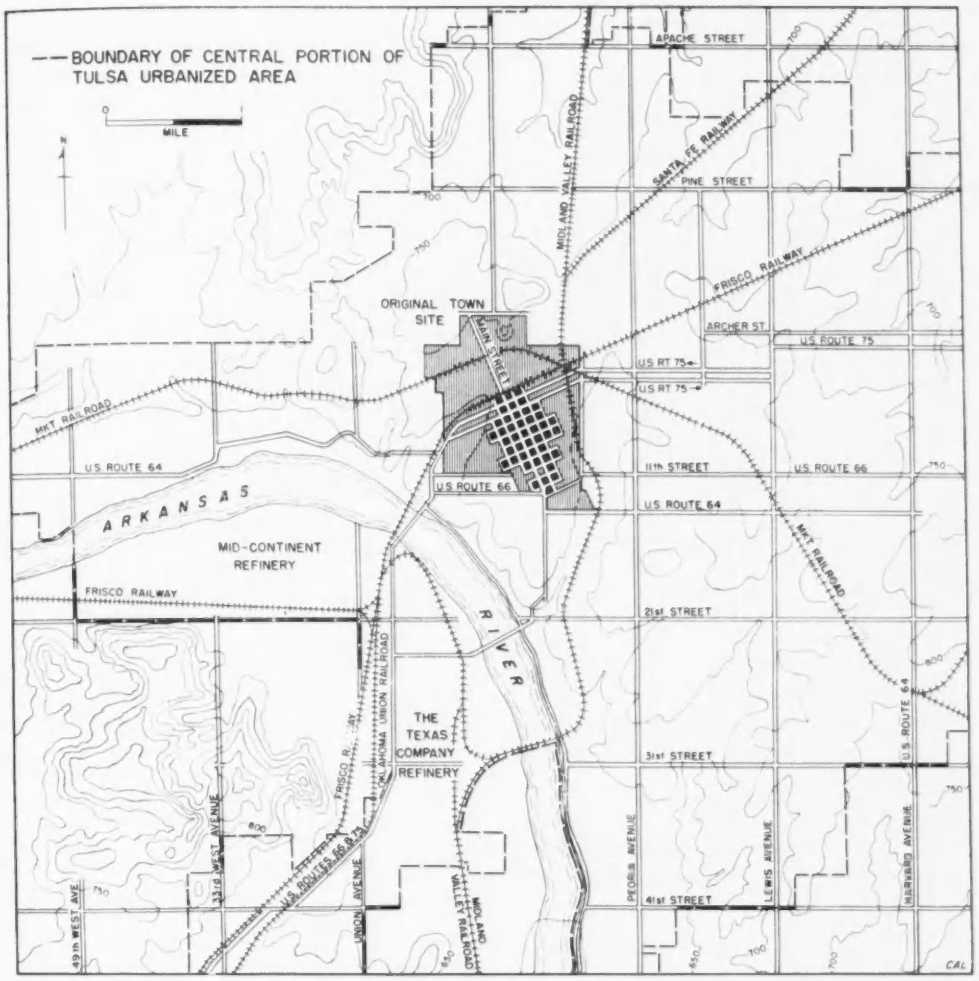

FIG. 16. The pattern of Tulsa's CBD is notably at variance with the survey system of the region. The district was laid out at right angles to a railroad. Compare with Figure 15. (Contour Interval: 50 feet.)

But Mobile's CBD does not live up to the city's current importance. It is small in area and most of its buildings are of only medium height. It is the least modern of any CBD analyzed in this study. Extremely narrow streets are lined by partially-used buildings that give an impression of decadence, out of character in so dynamic a city.

Mobile's CBD has the highest proportion of vacancy of any of the nine cities, 9.4 per cent (Fig. 25). This may be due to the fact that the District is characterized by old, two-, three-, and four-story buildings. It seems to be true that people who rent space in a CBD, today, want either of two types of location. They want ground-floor sites that are useful for retailing, or they want office space in tall buildings. Second, third, and fourth floors, of old, low buildings are not in demand. Where a city has an inheritance of old, multi-storied buildings, vacancy is likely to result. Such is the case in Mobile.

That steps are being taken to correct this situation in Mobile can be seen in the construction of new office buildings.

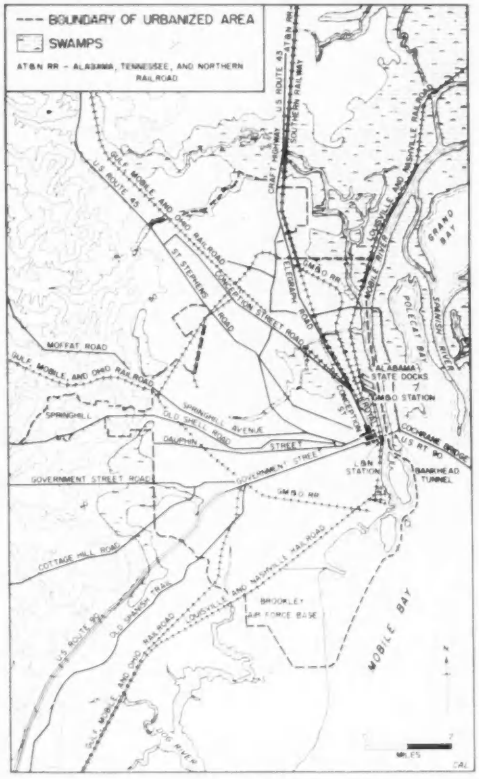

FIG. 17. The city of Mobile developed on the western shore of Mobile Bay. The CBD, like those of most port cities, has become less and less "central" as the city has grown. Compare with Figure 18.

The Gulf, Mobile, and Ohio Railroad Building, and the Waterman Steamship Company Building have been built since World War II to provide office space in the type of tall buildings in current demand.

In contrast to Tacoma's CBD, Mobile's has a low Central Business Intensity Index, almost as low as that for Worcester (Table I). The District gives the appearance of being greatly overexpanded in spite of its small size. This might be expected of a city that had reached its peak of population growth and had fallen into decline, but it does not seem logical in a city that is growing as is Mobile. One reason for Mobile's CBD being small in proportion to the city's population may be the presence of a separate Negro shopping district north of the main CBD. A combination of these two districts might make a single CBD that would be more in proportion to the city's population.

Mobile's CBD is not greatly hampered by barriers (Fig. 23), but the water front, reinforced by the Louisville and Nashville Railroad, does tend to block growth toward the east. And there is a group of government buildings that hampers growth to the south. Most of the District's expansion has been toward the north and west. There has been, however, very little movement of the peak value intersection, probably because the city's population remained nearly static for so many decades.

Mobile's CBD, like those of other port cities, is decidedly off center with respect to the city's population (Fig. 18) and with respect to its market area as well (Fig. 4). In its capacity as a market center, Mobile serves the coastal plain sections of eastern Mississippi and southern Alabama as far north as the Black Belt. This function may not

FIG. 18. Mobile's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

seem to be as important as Mobile's port function, but it is significant enough to cause Mobile to be classed as a diversified city with retailing predominant (Table III). Mobile's CBD will probably continue to be off center with respect to the urbanized area in spite of efforts to link the city with the eastern shore of Mobile Bay by means of a bridge and a tunnel.[5]

Roanoke

Roanoke is young as compared with most cities of the East (Fig. 1). Its development is explained in considerable part by the activities of the Norfolk and Western Railway. The real growth of the city dates from the 1880's, when the newly organized Norfolk and Western Railway moved its offices from Lynchburg to Roanoke, and the Roanoke Machine Works became the Roanoke Shops of the railroad. At the time it was chartered as a city, in the 1880's, Roanoke had a population of only 5000, but in that and following decades the city grew rapidly until today it has approximately 100,000 residents.

Relief features are important in explaining the location of the city and the trend of its railroads. The city lies in the Great Valley at the western base of the Blue Ridge (Fig. 20). Ridges dominate this section of the Valley, but the Roanoke River and its tributaries have developed a basin in which Roanoke is situated. The meandering river takes a west to east course across the lowland. In approaching Roanoke from the west the Norfolk and Western Railway follows the meanders of the river, but about at the city boundary the tracks branch. The main line leaves the river and takes a course that roughly bisects the city. A second railroad, the Virginian Railway, follows the river more closely and plays little part in the pattern of the CBD.

The trend of the Norfolk and Western is reflected in the city's street pattern: one set of streets tends to parallel the slightly curving east-west course of the railroad, and most of the blocks of the main body of the city are elongated in an east-west direction. This elongation of blocks may be seen in the CBD and also the tendency of the east-west streets to parallel the course of the railroad.

Though the chief role of the Norfolk and Western was that of getting the city started, the company is still Roanoke's largest single employer. But Roanoke is by no means a one-industry city. Trade and manufacturing now overshadow transportation in employment. A recent economic classification shows Roanoke as a diversified city with retail trade predominant rather than as a transportation center (Table III).

Let us consider Roanoke as a retail trading center. Most of the trade is drawn from the city itself, with Roanoke County forming a second-level hinterland. But it should be noted that Roanoke is the largest city in a rather large area. This third-level retail hinterland is represented by the 7000-square mile Roanoke Market Area delimited by the Curtis Publishing Company (Fig. 4).

Since Roanoke is the smallest in population of the nine cities, it might be expected that the city's CBD would have a corresponding rank in area and floor-space measures (Table I). The fact that, instead, it ranks seventh among the nine in these respects reflects in part a northward extension of the CBD across the Norfolk and Western tracks, an extension consisting of a hotel and an office block, both of which

[5] For a more detailed consideration of Mobile see Edward L. Ullman: *Mobile: Industrial Seaport and Trade Center*, University of Chicago, Chicago, 1943.

are Norfolk and Western Railway property.[6] This projection beyond a railroad is a development not found in any of the other eight cities.

For a city of its size, Roanoke has a CBD that is unusually metropolitan in aspect. It ranks fourth among the nine CBDs in average height, and it has a higher proportion of available floor space devoted to central business uses than any of the others (Table I). A high central business intensity such as

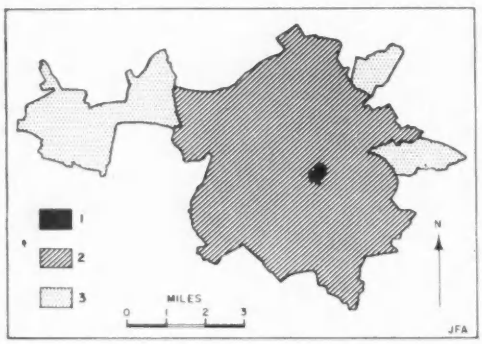

FIG. 19. Roanoke's CBD in relation to the incorporated city and its urbanized area. Compiled from United States Census maps. Numbers refer as follows: 1. CBD as delimited in first article of this series; 2. remainder of incorporated city; 3. urbanized area extensions beyond incorporated city.

this seems to be characteristic of the younger cities of the group.

A SYSTEMATIC TREATMENT OF CBD CHARACTERISTICS

The preceding section of this paper dealt with each of the nine cities and their CBDs individually. We are ready, now, to consider CBD characteristics systematically.

Size of the CBD

The popular conception of the size of a CBD is a two-dimensional one. It is true, a CBD does occupy a certain area. But a more realistic consideration of size includes the factor of height, so that in the last analysis it is the volume of a CBD with which we are properly concerned.

Total Floor Space in the CBD.—Since story heights are essentially standard, one may think of the volume of a CBD as expressed by its total floor space. The derivation of total floor space was described in the first article of this series. (It is obtained by adding the area of the upper floors to the area of the ground floor, minus alleys.) The advantage of such a figure, as compared with CBD area, is particularly evident in the case of Tulsa, where the growth of office buildings has meant expansion of the CBD upward and hence an increase in total floor space, without a corresponding increase in CBD area.

Central Business Floor Space in the CBD.—An even better measure of CBD size is obtained by subtracting, from total floor space in the CBD, the floor space devoted to non-central business uses: residence, public and organizational functions, industry, wholesaling, and vacancy. The remainder, central business floor space (or central business space), ranges from 75.5 acres for Mobile up to 207.7 acres for Tulsa (Table I). The reasons for variation in central business space have been dealt with subjectively in the city summaries. Here, we are concerned with possible relationships between central business space and other factors.

It was assumed in advance that central business space might be closely related to the population (and possibly the buying power) of the city's market area. To test this idea, the totals of central business space for each of the cities were plotted on semilog graph paper in descending order, and on the

[6] The bases for including these blocks in the CBD are discussed in Murphy and Vance, *op. cit.*, pp. 218 and 221. A "Y" viaduct now being constructed to carry traffic across the Norfolk and Western tracks will improve connections between the sections of the CBD on the two sides of the railroad right of way.

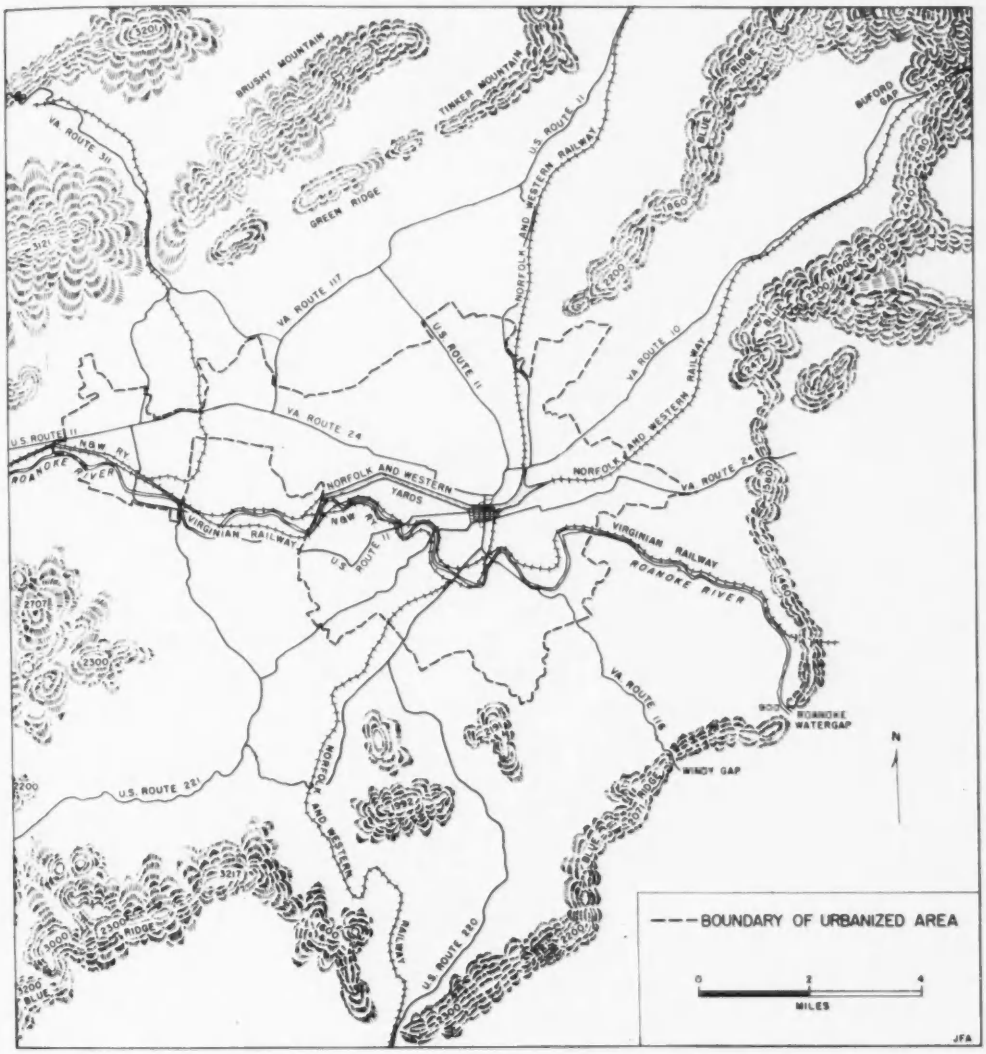

FIG. 20. Roanoke lies in a basin in the Great Valley at the western base of the Blue Ridge. The city is bisected by the main line of the Norfolk and Western Railway, and the CBD has an extension northward across the tracks. The area divided into blocks is the CBD. Compare with Figure 19.

same chart the populations of the Curtis Market Areas and the Standard Metropolitan Areas were plotted (Fig. 21, C). The fact that little, if any, correspondence of the curves is evident, suggests that CBD size is not as closely related to the population of these larger areas as has been generally supposed.

A second possibility is that central business space may vary with population of the urbanized area or of the incorporated city. When these values are plotted against central business space it is found that, although the population of the urbanized area shows little relation to central business space, there appears to be some relationship between population of the incorporated city and central business space (Fig. 21, B).

The reason for a closer relationship of central business space to incorporated

city population than to urbanized area population may well be that the typical urbanized area contains outlying urban centers with their own stores, and that these detract from the importance of the central city's CBD. This appears to be the case in Phoenix, where several outlying centers are large enough to compete materially for some of the business of the central district.

Since CBDs are areas of trade and office activities, Census data representing these activities were compared with central business space (Fig. 21, D-G). The fact that the numbers of clerical workers, sales workers, retail trade employees, and wholesale trade employees vary rather closely with central business space may not be surprising, but study of the chart serves to bring out several interesting points. First, central business space seems to vary more closely with incorporated city data than with urbanized area data, thus tending to confirm the idea that the size of the CBD depends more upon the incorporated city than upon the adjacent built-up areas. Second, the rather close correspondence between variation in central business space and variations based upon the several Census items serves as a rough verification of the techniques used in this study. Third, the variation in central business space corresponds so closely to that of retail and wholesale employees in each city that one could almost use the number of these employees to estimate the central business space. Each thousand retail trade employees in the incorporated city, for example, appears to mean some 12 to 13 acres of central business floor space. It should be emphasized, however, that these tentative conclusions are based on a limited number of cities of moderate size.

Shape of the CBD

As was brought out in the discussion of size, the CBD of a city is three-dimensional, but this shape is hard to evaluate and hard to express. Hence, most discussions of CBD shape have concentrated on the plan view or outline.

CBD Outline.—When the CBDs of the nine cities are presented on a single chart, a striking variety of outlines appears (Fig. 22). The course of each boundary is largely the result of block shapes, since blocks were the units used in delimitation. There are many right angles, reflecting the predominance of grid street patterns. Even Worcester, whose street pattern departs farthest from a grid, has many angles in its CBD boundary that approach right angles. Had the delimitation technique been based on lots, the boundaries of the various CBDs would have shown much the same irregularity but finer detail (see Figure 3 in the first article of this series). Coarseness of outline is particularly noticeable in the CBD of Salt Lake City, a result of the fact that average block size is more than three times that of any of the other eight districts (Table I).

Looking broadly at the CBD outlines, one sees little evidence of the star-like pattern, or of the "tilted square or diamond" pattern, that has been postulated as the theoretical shape of a CBD.[7] The former is hardly to be expected since none of the CBDs studied here has radial streets sufficient in number to result in such an outline. But since grid patterns predominate, and since in many instances the CBD has two principal, intersecting (and hence radial) streets, we might expect a tilted square

[7] George W. Hartman: "The Central Business District—A Study in Urban Geography," *Econ. Geog.*, Vol. 26, 1950, pp. 237–244, reference on p. 239.

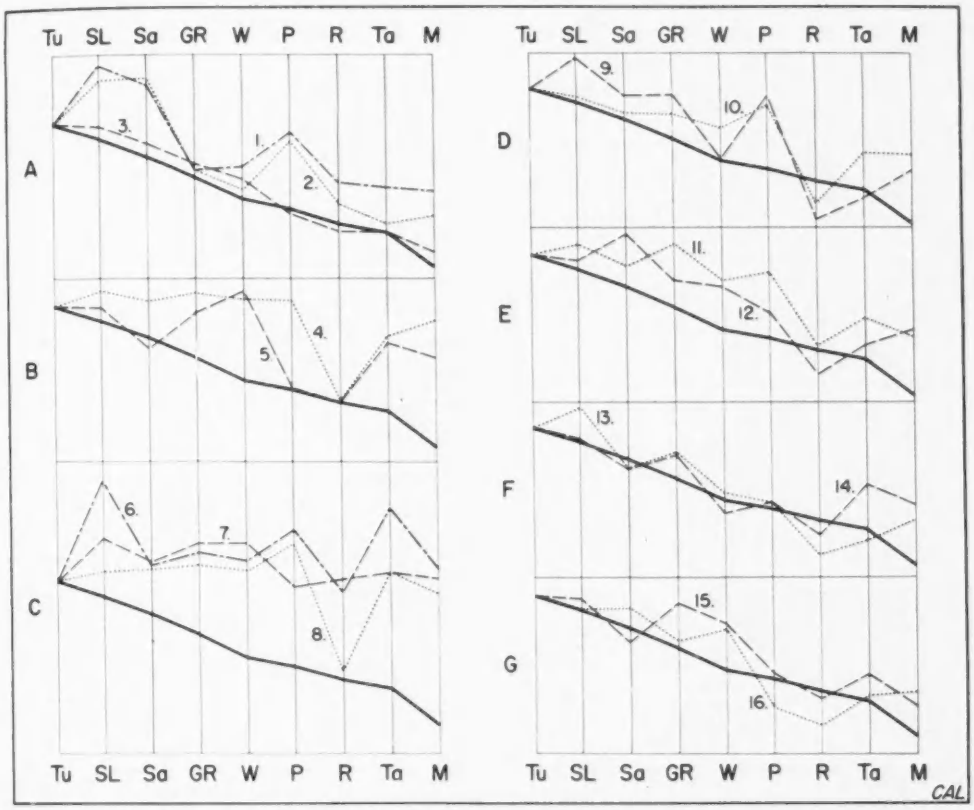

FIG. 21. In this semilog chart the city to city variation in CBD size (central business space in the CBD) is compared with the city to city variation in other data. In each section, CBD size has been plotted as a solid line. Connecting the plotted points gives a line with which other curves can be compared to test the degree to which the several factors vary from city to city at the same rate as central business space. No absolute values are indicated, as it is only the shapes of the curves that are being compared. To facilitate comparison, all curves in each section have been shifted so that they have the same starting point.

The numbers refer as follows: 1. ground floor area; 2. gross area of CBD; 3. total CBD space; 4. population of urbanized area; 5. population of incorporated city; 6. area of urbanized area; 7. population of Curtis Market Area; 8. population of Standard Metropolitan Area; 9. wholesale employees in urbanized area; 10. retail employees in urbanized area; 11. sales workers in urbanized area; 12. clerical and kindred workers in urbanized area; 13. wholesale employees in incorporated city; 14. retail employees in incorporated city; 15. sales workers in incorporated city; 16. clerical and kindred workers in incorporated city.

Section A tests the degree to which total area, ground floor area, and total space in the CBD vary with central business space. The lack of correspondence of the area curves and the space curves reflects chiefly variations in average building height in the CBD from city to city. In Section B the possible relationships between population data for the incorporated city and for the urbanized area and central business space are investigated. It is clear that central business space varies more closely with incorporated city population than with that of the urbanized area. In Section C the lack of significant relationships between central business space and area of urbanized area, population of Curtis Market Area, and population of the S.M.A. is obvious. From Sections D and E it is apparent that certain trade and employment data for the urbanized area vary significantly with central business space. Finally, Sections F and G make it clear that these same factors for the incorporated city are even more closely related to central business space.

For basic data and for sources of data see Tables I and II.

or diamond. A suggestion of this pattern may be seen in the northeastern quadrant of Phoenix's CBD.

However, it seems unrealistic to think of the space between the radial streets as having been filled in sufficiently to form a true diamond, since location on or near one or the other of the radial streets is so important for central business functions. Filling in of the CBD between the radials goes on near the peak value intersection, but with increasing distance from the center these "in between" areas rapidly lose their attractiveness for central business activities. Instead of a diamond, therefore, the idealized outline seems to be more nearly one of a four-pointed area with concave sides, or, better still, to approximate a quadrate cross (Fig. 24). There is a suggestion of this shape in the CBD outlines of Phoenix, Roanoke, and Mobile. And, although it is not much in evidence in the outline of Worcester's CBD in Figure 22, it is clearly shown on the map of the district delimited on a lot basis (see Figure 2 in the first article of this series). It is likely that the current ribbon development along streets leading away from the CBDs of various cities is causing the Districts to approximate more and more the quadrate cross.

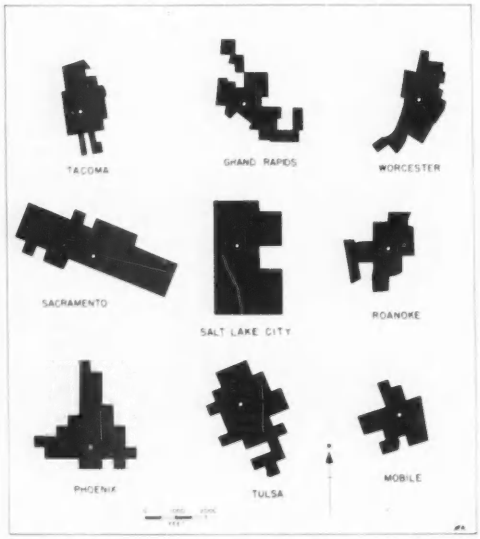

FIG. 22. Plan view of the CBDs. Each peak land value intersection appears as a white dot. Compare with Figure 23.

The concept of an idealized outline, whether quadrate cross or diamond, is based on the idea of two intersecting thoroughfares of equal importance. Actually, this perfect balance is probably never found, so no district can be expected to achieve more than a rough resemblance to a theoretical shape. When the two intersecting thoroughfares differ considerably in importance, the district becomes elongated along one axis. The shapes presented by the CBDs of the nine cities might be classified as follows: (1) fairly equivalent intersecting axes, an approximation of a quadrate cross—Roanoke, Mobile, and, to a certain degree, Phoenix and Worcester; (2) dominant single street, with resulting elongation of the CBD—Worcester, Grand Rapids, Sacramento; (3) parallel streets that exceed in importance any crossing street, with a resulting block-like CBD—Tulsa, Salt Lake City, and possibly Tacoma.

The CBD as a Three-dimensional Figure.—But the CBD, as we have pointed out, is not just two-dimensional. It is a solid, and might well be thought of as some modification of a pyramid. If we follow the idea of the CBD outline being diamond-shaped, then the pyramid would have a square base, and each of its four corners would rest on one of the four radiating streets. If, however, we follow the idea of the quadrate cross in place of a diamond, the solid would no longer be a simple pyramid, but would have to be modified accordingly.

Since the modifications would be difficult to compute and would not greatly change the results, it is sufficient for our purpose at the moment to concen-

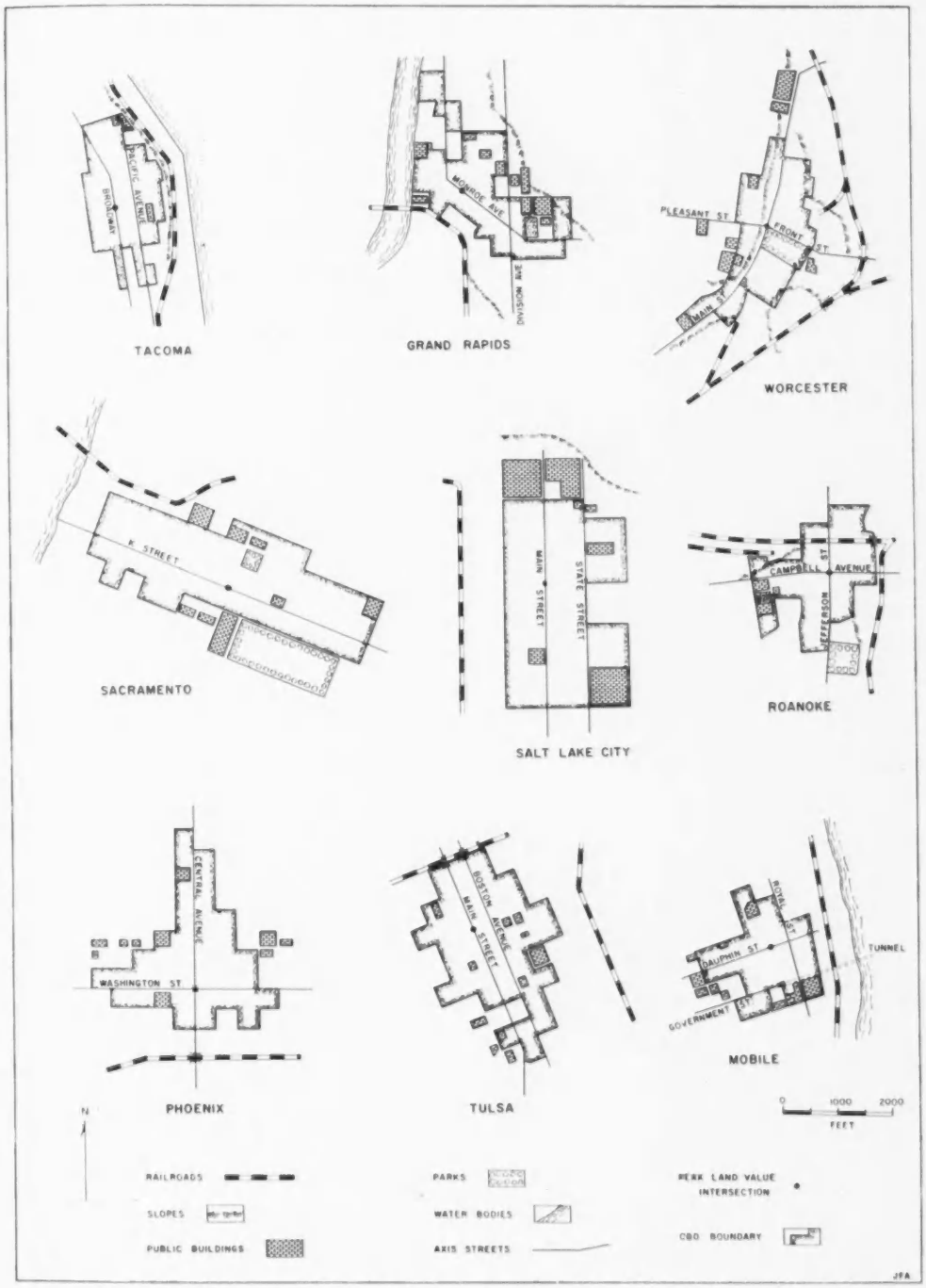

FIG. 23. Barriers have affected the shape of the CBD through limiting expansion in certain directions.

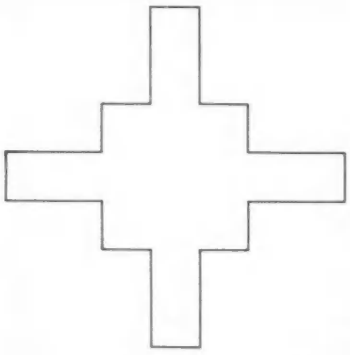

FIG. 24. A quadrate cross. This seems best to represent the idealized outline of the CBD.

trate upon the idea of the CBD corresponding to a pyramid-like figure. The base corresponds to the ground floor area of the CBD (Table I). The volume amounts to the central business floor space in the CBD (Table I), which, as was pointed out earlier, may be thought of as volume if a uniform story-height is assumed. The height may be calculated by using the formula $V = 1/3\ Bh$. Applying this formula to each of the nine CBDs the following pyramid heights are obtained: Tulsa, 7.8 stories; Grand Rapids, 7.2 stories; Worcester, 6.0 stories; Roanoke, 5.8 stories; Tacoma, 5.7 stories; Salt Lake City, 4.6 stories; Sacramento, 4.6 stories; Mobile, 4.5 stories; and Phoenix, 4.4 stories.

This concept is admittedly theoretical, but there is some value in thinking of it in connection with the CBD. The height of the pyramid as computed here is a way of expressing the relation of the ground floor area to the central business floor space. In other words, it relates areal size of the CBD to volume.

There is a mathematical relationship between the height of the CBD pyramid and the Central Business Height Index (Table I). The Index is computed by dividing the total floor space devoted to central business uses by the total ground floor space of the CBD. Hence, the Central Business Height Index amounts to one-third as many stories as the peak of the pyramid.[8]

Neither the pyramid heights nor the Central Business Height Indexes are more than theoretical, of course. The Central Business Height Index assumes that central business uses are spread evenly over the district, which we know is not the case. On the other hand, the height of the pyramid assumes that central business uses tend to pile up, reaching a peak at the geographic center of the CBD, which we know is not exactly the case, either, though it does come closer to describing the actual situation.

Factors that Limit CBD Expansion.—To what extent is the shape of a CBD related to the barriers that surround or interrupt it? The subject of barriers was discussed earlier as it arose in the case of each of the CBDs. At this point we need only to summarize and generalize our findings. That there are barriers to the expansion of a CBD is obvious. Railroads, water bodies, areas devoted to public buildings, and a variety of other tangible land uses act as barriers. In some cases, the CBD may approach the barrier closely. This usually happens with public buildings, where the CBD may be adjacent to them or occasionally surround them. It happens also in the case of parks. But, where there are railroad and water barriers, the CBD does not, usually, abut directly upon these barriers. There is commonly a cushion of other uses between the CBD and the barrier.

Relief as a barrier deserves special mention. There is no doubt that steep slopes serve as an obstacle to CBD

[8] Applying the formula for the volume of a pyramid to the CBD, it can be written as follows: central business floor space $= 1/3$ (total ground floor space) h. Then $h = 3$ (central business space $\div$ total ground floor space) or $h = 3$ (Central Business Height Index).

development; if it is at all possible, steep slopes are avoided. But we have examples where steep slopes have been used, just as we have one example in the nine cities of the CBD crossing a railroad.

Just how important these tangible barriers are in helping to determine the shape of a CBD is difficult to assay. Grand Rapids and Worcester, both of which have tall, compact CBDs, are hampered by barriers (Fig. 23). But Tulsa's CBD, which is even taller and even more compact, is not particularly restricted by tangible barriers. Obviously, there are other barriers to the expansion of a CBD than tangible, physical ones.

It has been suggested that CBDs tend to be limited by a distance factor. The district has been called a "walking zone." Since people usually walk from one part of the CBD to another, there is a certain amount of reluctance to use areas that are located too far from the peak value intersection for easy walking. In American cities of the size here considered, however, the distance factor is offset by the fact that in marginal sections of a CBD, where space is more available for parking, the automobile can be used. There seems to be a marginal zone in a normal CBD that might be called the automobile-oriented zone. Perhaps the walking zone is coincident with the so-called hard core of the CBD, and the automobile-oriented zone is related to the part of the CBD that lies outside the hard core.[9]

However, sooner or later, the CBD comes to an edge where other uses take over and the combination of floors of central business use plus the intensity of such use does not warrant including a block in the CBD. This will happen in CBDs that are uninhibited by barriers as well as in those that are more restricted. But no doubt the breaking point comes sooner in a direction in which a CBD has to overcome tangible barriers than it does in other directions.

[9] Murphy and Vance, *op. cit.*, p. 192 and Fig. 2, p. 193.

Land Use in the CBD

Even more important than the size and shape of the CBD, are the ways in which the district is occupied and used.

Land use proportions for each of the nine CBDs and for an average of all of them are shown in summary form in Figure 25. The chart serves, first of all, to give a picture of the land uses that one may expect to find in the average CBD. It can be used in other ways as well. One can see, for example, the land use pattern of each of the nine CBDs. But individual CBDs were discussed in an earlier section of this paper in connection with the cities they serve. Here, we will consider land use types and groups of land use types to see how their proportions vary from city to city, and why.

Non-central Business Uses and the Central Business Intensity Index.—Looking at the three major divisions of the land use chart, it can be seen that one of these groups consists of non-central business uses, and that both of the other groups consist of central business uses. The chart presents graphically, therefore, the Central Business Intensity Index, i.e., the proportion of all CBD floor space that is devoted to central business uses. It is immediately apparent that Roanoke, Tulsa, and Phoenix have the smallest proportions of non-central business uses; in other words, they have the highest Central Business Intensity Indexes (Table I). All three of these cities are young. By the time they were built, there was little demand for space at the center of the city except for true central business uses. It can

be seen from the chart, too, that these cities have the lowest percentages of central business space devoted to industry, and that all three are below average in residential land use.

Worcester's CBD is at the opposite end of the scale, with the lowest Central Business Intensity Index of the nine. This is partly because the city devotes more central business space to industry and to residences than do most of the other cities, a condition that is largely a reflection of prevailing custom in New England at the time Worcester developed. Moreover, a large Common and the presence of much church property gives the district an unusually large proportion of public and organizational land use. Mobile's CBD, with almost as low an intensity index as Worcester's, has a large amount of upper story vacancy, apparently the result of overbuilding of two- and three-story structures in the past. Both of these cities are above average in the proportion of space devoted to wholesaling, though the proportion is higher still in Salt Lake City, which is known for its specialization in wholesaling (Table III).

Service, Financial, and Office Uses.—A second major group shown on the chart is "service, financial, and office uses." Tulsa's CBD has the highest proportion of space in this group, reflecting, of course, its great development of offices, both "headquarters" and general. Grand Rapids is second in its proportion of space in this group, and here, too, the explanation is the large office development. This high proportion of office space reflects Grand Rapids' importance as a regional trade and service center, a point that is often overlooked because of the city's importance as an industrial center. Worcester and Mobile have the lowest percentage of CBD space devoted to service, financial, and office uses. To some extent these two cities may be overshadowed by near-by, larger centers—Boston, in the case of Worcester, and New Orleans, in the case of Mobile. But, in addition to this, for reasons mentioned earlier, their proportions of non-central business space are large, and this tends to keep down their percentages in other groups.

Another point of interest in connection with this group of land uses is the large development in Roanoke and Sacramento of transient residence, a land use made up chiefly by hotels. Roanoke's situation is explained, in considerable part, by a large hotel and grounds operated by the Norfolk and Western Railway. This attracts a constant stream of conventions and other regional meetings to the city. In Sacramento the situation is even clearer: the city is a state capital and also lies in a region that needs to house a large seasonal migrant labor group. These same conditions help to explain the importance of food retailing in Sacramento's CBD.

Retail Business Land Uses.—In the third group of land uses shown on the chart, "retail business uses," it will be noted that Tacoma and Roanoke rank first and second, and that Phoenix ranks third. As pointed out earlier, the development of Tacoma's CBD on steeply sloping land appears to have resulted in an unusual amount of ground floor retail space (see p. 312).[10] The basis for Roanoke's high proportion of retail space is not so clear, although the city is known as an active retail center. The high proportion of retail business space in Phoenix is not surprising since Phoenix is regarded as a retail city (Table III).

It may be seen from the chart that

[10] The high proportion of space in retail business may reflect, in part, the difficulties of mapping urban land use on a steeply sloping site. On such sites, mapping techniques that work well in flatter areas prove hard to apply.

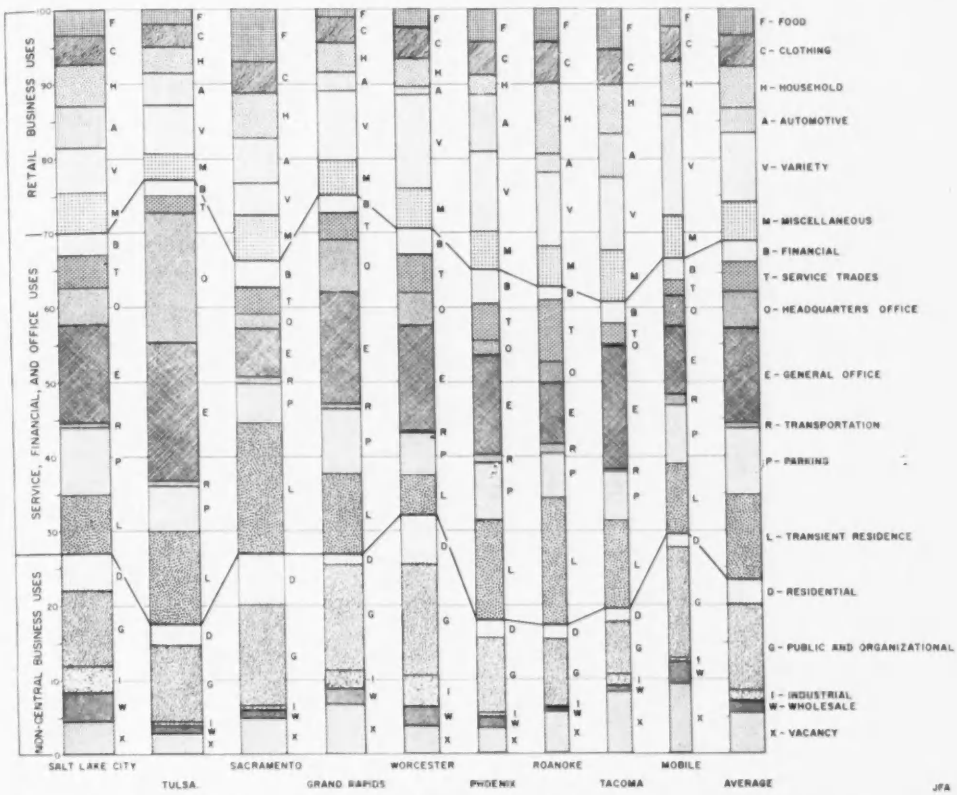

FIG. 25. Percentage chart showing proportions of total floor space of each CBD (and of an average of the CBDs) devoted to various uses. The bars are proportional in width to total floor space in the CBD. The proportions shown are based on data from field mapping carried on during 1952 and 1953.

It is important to keep in mind that the picture presented by each bar on the chart is one of land use in the CBD, not in the city. For example, a smaller proportion of automotive sales is shown for Worcester than for any of the other eight cities. This does not mean that in the city of Worcester automotive sales are less important than in the other cities. It merely means that less of this business is carried on within the Worcester CBD. Automotive sales in Worcester happen to be concentrated in several areas that are well outside the CBD.

the proportion of Tulsa's central business space devoted to retailing is less than that for any of the other cities. This does not mean, however, that the city has little retailing. As a matter of fact, it has more employees in retail trade than any of the others. But each of the bars on the chart represents 100 per cent of central business space, and offices occupy so much space in Tulsa's CBD that the percentages of space devoted to other uses are reduced accordingly. Grand Rapids' CBD, another district with more than average office development, has only a slightly higher proportion of retail business use than Tulsa's.

From field data too detailed to be reproduced in this article, comparisons are possible within subdivisions of the chart. For example, supermarkets were mapped as one subtype under "Food." No supermarkets were recorded within the CBDs of Grand Rapids, Mobile, or Phoenix; but to some degree they were present in the CBDs of all the other cities. Yet they seem to be out of place; as a CBD function the operation of supermarkets has been declining. They are being replaced by supermarkets

farther away from the center of the city, in areas where ample parking space can be set aside.

Land Use Normal to the CBD.—Probably the most valuable purpose served by the sort of land use analysis that has just been presented is that it leads to conclusions as to which land uses are typical of a CBD and which are not. The situation is summed up in Table IV.

It is interesting to note that most of the retail types listed in Group A were mentioned by Proudfoot, in a study carried on some 20 years ago, as typical of the CBD. He wrote, ". . . Here retail occupance is characterized by large department stores, numerous women's and men's clothing stores, furniture stores, shoe stores, jewelry stores, and similar outlets selling shopping goods. Added to these, though of subordinate importance, there are numerous drug stores, tobacco stores, restaurants, and other stores selling convenience goods . . . ."[11] Since Proudfoot was concerned only with retail outlets for commodities, his list is, of course, not as extensive as the list of "Present and apparently typical" land uses given in Table IV.

A logical step beyond this analysis would be to suggest what combination of CBD land uses would bring the greatest prosperity to a city. This poses a problem that might be solved through further comparative studies of CBDs.

TABLE IV

A CLASSIFICATION OF LAND USES IN THE CBD

The order in which the items appear on each list is not intended as indicative of their importance but merely represents the order in which they were tabulated in the office. No attempt has been made to include all minor forms of land use. (From tabulations based on the authors' field notes.)

A. Present and apparently typical:
Restaurants
Women's clothing
Men's clothing
Furniture
Hardware and appliances
Department stores
"5 and 10" stores
Drug stores
Jewelry and gifts
Amusement establishments
Banks
Insurance and real estate
Personal service (barbers, beauticians, etc.)
Clothing service
General offices
Commercial parking
Hotels and other transient lodging
B. Rare enough to be absent or essentially so from one or more of the CBDs:
Supermarkets
Automobile sales
Service stations
Accessory, tire, and battery sales
Newspaper publishing
Headquarters offices
Railroad station
Bus station
Residences
Industrial
Wholesale
C. Occupying substantial space in all CBDs but not typically central business land use:
Public land and buildings
Organizational and charitable institutions
Vacant building or lot space

CONCLUSIONS

In fulfilling the objectives stated at the beginning of this article, the authors arrived at a number of generalizations. Some of these generalizations are hardly debatable; others, although strongly indicated, cannot be fully substantiated from the evidence now at hand. A further qualification is needed. The evidence is based on only nine, moderate-sized cities chosen from within a limited size range. Keeping in mind these limitations, the following may be listed as the principal findings:

1. Specific transportation features—port works, railroad stations, early road junctions—generally were responsible for the original location of the city. This initial development, in turn, formed the nucleus of the modern CBD.

2. As cities grow, many CBDs tend to become more and more off center for their urban area as a whole. Of course, this is particularly true of port cities.

[11] Malcolm J. Proudfoot: "City Retail Structure," *Econ. Geog.*, Vol. 13, 1937, p. 425.

3. The size of a CBD is best measured by the total floor space at all levels devoted to "central business" uses. Since a uniform story height is assumed, this total may be regarded as the volume of the CBD.

4. CBD size varies with incorporated city population more than with that of the urbanized area or that of the tributary market area of a city.

5. Variations in CBD size from city to city are so closely paralleled by variations in number of employees in commercial activities, as reported by the Census, that such data might be used to estimate the central business space in a CBD.

6. The theoretical outline of the CBD seems best to approximate a quadrate cross; the theoretical shape of the CBD is that of a modified pyramid.

7. Where a CBD has only one important axis, a narrow, elongated District is likely to result.

8. Relative equality of several parallel axes tends to produce a broad, elongated CBD.

9. Where two intersecting axes are of approximately equal importance the District approaches an equidimensional outline.

10. Railroads and rivers are important barriers to CBD expansion. This barrier effect, in the modern city, is reflected in a belt of non-central business uses, so that the CBD rarely reaches a railroad or river.

11. Parks, and public buildings, where they are extremely large or grouped, may serve as barriers to CBD expansion.

12. Slope is a powerful deterrent to CBD expansion.

13. The land uses typical of the CBD—the ones that are truly "central business" in character—are offices and retail outlets for goods and services.

14. The CBD, more than any other business area of the city, serves the entire community rather than any one part of the city or any one ethnic group.

15. Ordinarily, vacancy in the CBD reaches its greatest proportions in old cities and cities that have grown old before their time. Within these cities it is greatest in old buildings, several stories in height.

16. The current demand for office space in CBDs is focused upon new, high office buildings.

17. There seems to be a type of new, Western city, built essentially on a single plane, but having a few peaks of tall buildings for offices, hotels, and department stores.

18. The CBD has ceased to be entirely a "walking zone." It has acquired outer sections that are, in part, automobile oriented.

19. The size and shape of a CBD are constantly changing.

20. In most cities the position of the peak land value intersection has shifted at one time or another, but where it corresponds to a particularly well developed route focus the peak point may remain stable for a long time.

These findings and others not listed here represent only a beginning. More studies of CBDs are needed. For example, the Districts of larger and smaller cities than those studied here need to be mapped and analyzed, so that the relationships between CBD size and city size can be worked out more fully. It would be of interest, too, to study the CBDs of various types of cities—port

cities, manufacturing centers, state capitals, etc.—to see how the Districts vary with the type of city. Equally intriguing is the whole question of how CBDs differ regionally. Is there a typical Western CBD? Do the CBDs of Southern cities differ from those in other parts of the country? Is a typical CBD for the American city in the process of evolution?

The question might well be asked, Why were land values neglected in comparing the CBDs? The answer is, as explained in the first paper, that land values are extremely difficult to use and often impossible to obtain. But the study of CBD land values is important. More work is needed along this line. Land values in the CBD, if properly interpreted, might represent the key to much that we would like to know.

Another characteristic that should be studied is CBD quality. In the delimitation technique used in this project, no measure of quality was included, yet the writers are well aware of definite contrasts between CBDs in this respect. It is undoubtedly true, for instance, that the CBD of Tulsa is of much higher average quality than that of Tacoma. But quality is complex. It includes more than the value of buildings and the level of merchandise handled by the stores. There is a dynamic aspect, too. It involves the questions of whether, through the erection of new buildings and the remodelling of old ones, a city's CBD is being kept up to date, and whether the District really reflects the potential of the area it serves. Subjective judgments are not sufficient to bring out such contrasts, but a good, objective measure of CBD quality remains to be developed.

It is not intended to give the impression that the lines of research suggested here represent entirely uncharted seas. As a matter of fact, work has been done and is being done on some of these problems, but such work is little more than a start. The points of view of various disciplines are needed; certainly one of these disciplines is urban geography. In such research, comparative studies based on uniformly delimited CBDs should, in the long run, prove more productive than studies of single Districts.

Of course the study presented in this paper deals with the CBD as a whole, and this is only part of the story. Obviously, the district has an internal structure as well. This will form the subject of the third and concluding article of this series.

DISTRIBUTION OF POPULATION ON HISPANIOLA

Donald R. Dyer

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FOR the first time in history detailed, reliable data on the distribution of population on the island of Hispaniola are available. Detailed censuses of population in the Dominican Republic had been made in 1920 and 1935, but the cooperation of Haiti in the 1950 Census of the American Nations resulted in the first detailed enumeration of its population.[1] The 1950 censuses for both countries contain data for major territorial divisions, for subdivisions of major territorial divisions, and for the national capital and the capitals or principal cities of major territorial divisions. The population of Haiti for 1950 was 3,111,973, that of the Dominican Republic was 2,121,083, making the total population of the island of Hispaniola 5,233,056.[2] This total is as large as the estimated population of Cuba and places the island in the highest category of populations in the Caribbean area (Fig. 1).

Within the island of Hispaniola Haiti occupies approximately the western one-third, about 10,700 square miles, and the Dominican Republic occupies the eastern two-thirds, about 19,300 square miles. Thus, comparing areas, one might expect to find one-third of the population in Haiti and two-thirds in the Dominican Republic, but such is not the case. In fact, the ratios are almost reversed, Haiti having about three-fifths and the Dominican Republic about two-fifths, resulting in densities of approximately 290 per square mile in Haiti and 110 per square mile in the Dominican Republic. One should note, however, that comparisons of arithmetical density have little value unless physical conditions such as landforms, climate, vegetation, soils, and mineral resources, are nearly uniform throughout. Such is certainly not the case in Hispaniola.

Diversity of Land Features

Hispaniola is irregular in shape, broken into several peninsulas extending from a central core of mountains (Fig. 2). The main mountain mass, the Cordillera Central, lies largely in the Dominican Republic and has peaks extending to 10,000 feet elevation; and, although it forms the backbone of the big eastern peninsula, its elevations are mostly less than 1500 feet above sea level in the peninsular section. Another large mountain mass forms the southern part of Haiti, the Massif de la Selle, and the southwestern part of the Dominican Republic, the Sierra de Bahoruco. Near the border the mountains rise sharply from sea level to more than 8000 feet elevation. The mountainous system

[1] Various sources class the 1919 enumeration in Haiti as a "census." The release of the 1950 census, however, is designated the *premier denombrement*, or first enumeration.

[2] Republique d'Haiti, Bureau of Recensement, *Recensement de la Republique d'Haiti;* premier denombrement de la population (Port-au-Prince, 1950); and República Dominicana, Dirección General de Estadistica, *Tercer Censo Nacional de Población, 1950;* población de la República según el sexo, por provincias, comunes, y distritos municipales (Cuidad Trujillo, 1950).

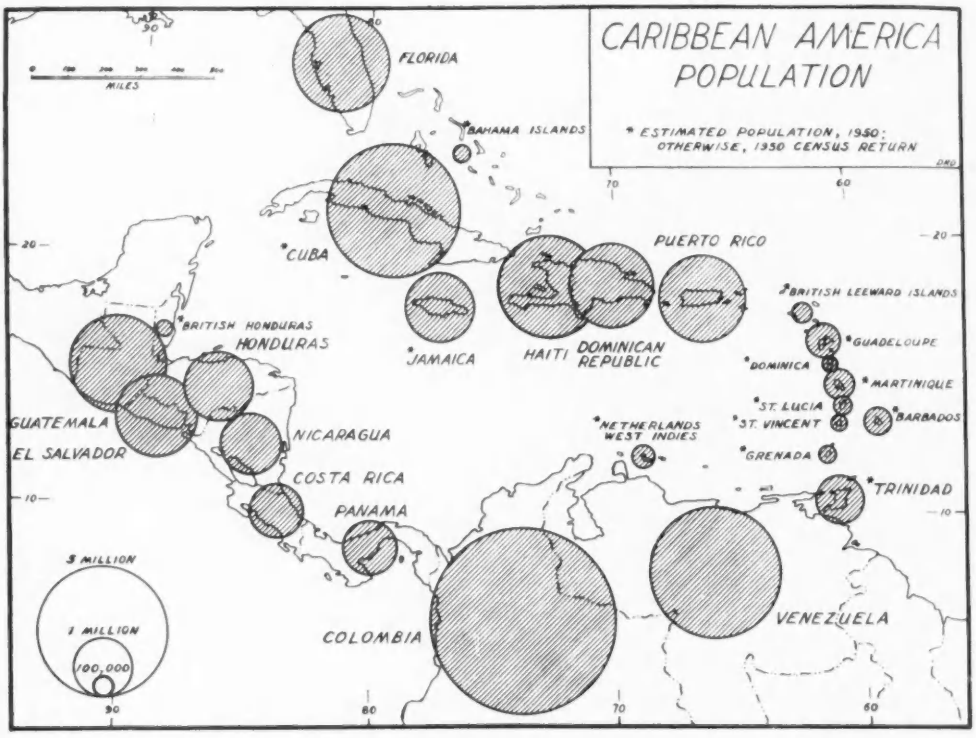

FIG. 1. The combined populations of Haiti and the Dominican Republic total more than 5 million, which is nearly as great as the estimated population of Cuba for 1950.

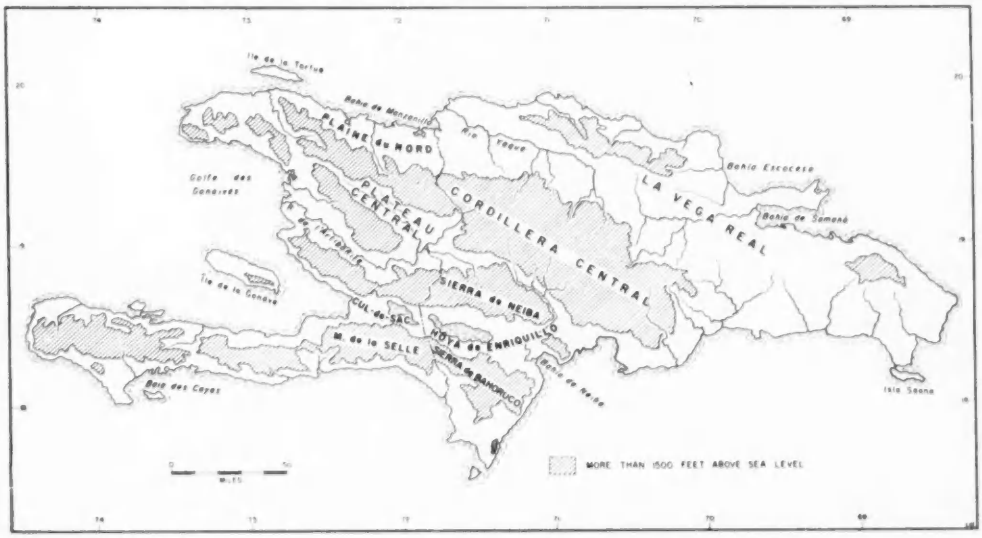

FIG. 2. The island of Hispaniola consists of several peninsulas extending from a mountainous core. Haiti, occupying the western one-third of the island, is nearly all peninsular. The Dominican Republic contains the highest and broadest mountain system.

continues westward along the southern peninsula of Haiti, where a few breaks allow passes at less than 2000 feet. A narrow coastal plain, widening noticeably around the Baie des Cayes, extends around the southern peninsula.

The remainder of Hispaniola is made up largely of parallel mountain ridges and valleys. The plains areas, the most heavily-populated parts of the island, are considerably less extensive in Haiti than in the Dominican Republic. The largest plain extends along the north coast of Haiti, where it is called the Plaine du Nord, eastward between the large Cordillera Central and the relatively low Cordillera Septentrional to the Bahía de Samaná. The eastern part of this wide lowland has been called appropriately La Vega Real, The Royal Fertile Plain. Another large plains area occupies most of the big eastern peninsula. Its rolling surface slopes gently southward to the Caribbean Sea. Other plains of note are the Cul-de-Sac lowland, called the Hoya de Enriquillo in the Dominican Republic, the Artibonite Valley, and the Plateau Central. The Cul-de-Sac, literally translated "blind alley," occupies the fault depression between the southern mountain system and an outlier of the Cordillera Central, called the Chaine de Mateaux in Haiti and the Sierra de Neiba in the Dominican Republic. The lowland is nearly flat and lies close to sea level; in fact, Lago de Enriquillo near the middle of the depression actually is nearly 100 feet below the level of the sea. The Valley of the Artibonite River, the largest river in Haiti, is wide around the Golfe des Gonaïves but narrows rapidly toward the interior, where the river has cut through a water pass between the Montagnes Noires and a branch of the Sierra de Neiba. In the upper reaches of the Artibonite a large interior plain, the Plateau Central, has been cut out. The interior plain, which lies mostly below 1500 feet elevation, is most extensive in Haiti but extends eastward into the Dominican Republic.

Coupled with the diversity of landforms outlined above is a diversity of climate, vegetation, and soils—all interrelated, and related to the landforms as well. In general, northward- and eastward-facing slopes are humid and have abundant vegetation and leached soils. The dry, scrub-forest areas with alkaline soils generally are the westward- and southward-facing slopes, those that are sheltered from the moisture-bearing trade winds, but there are notable exceptions to this generality—particularly the southern peninsula of Haiti, where both slopes are humid. Especially dry areas are the Cul-de-Sac and Hoya de Enriquillo lowland, the Artibonite plain, and the valley of the Rio Yaque del Norte in northwestern Dominican Republic. The southeastern plains of the Dominican Republic are subhumid, largely because of orientation and because of the absence of high elevations which would intercept moisture-bearing winds.

REGIONAL DISTRIBUTION OF POPULATION

For convenience in grouping patterns of population distribution 16 population regions can be outlined (Fig. 3). A major criterion used in setting up the regions is simple areal variation. In other words, boundaries are drawn *around* areas of concentration and *through* zones of sparseness. A major variation from this principle is the use of the national boundary, which is certainly a strong cultural break. Another criterion which sometimes upsets apparent areal compactness is the orientation of population around a regional center because of the availability of

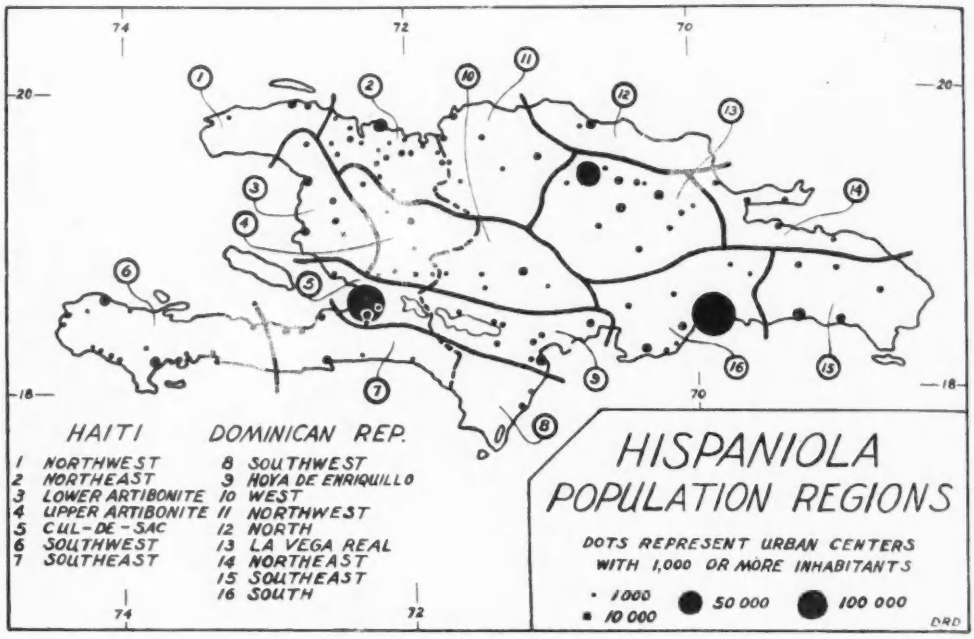

FIG. 3. The 16 population regions of Hispaniola have been set up largely on the basis of areal variation. Boundary lines correspond generally to zones of sparse settlement surrounding somewhat compact groups.

transportation toward a center. For example, in Northwestern Haiti, the boundary between the population centers on the mainland opposite the Ile de la Tortue and the dense concentrations of population in the productive Plaine du Nord to the east was made on the basis of regional orientation around Port-de-Paix, the largest town and the regional center of northwestern Haiti. Port-de-Paix is connected with the other four population centers along the northern coast of the peninsula within the northwestern region by a road. The easternmost center is not connected by road with the centers in the Plaine du Nord. The approximate populations of the 16 regions are shown in Table I.

The distribution of population on Hispaniola reflects the conditions of the natural environment outlined above. Almost all of the centers of population are located on plains. Only 10 of the 108 centers of communes in Haiti and only 9 of 81 centers of communes and municipal districts in the Dominican Republic are above 1500 feet elevation, in spite of the extremely mountainous nature of the land and the heavy

TABLE I

POPULATION TOTALS FOR THE SIXTEEN POPULATION REGIONS OF HISPANIOLA

Northwestern Haiti	180,000	Hoya de Enriquillo Lowland	144,000
Northeastern Haiti	541,000	Western Dom. Rep.	154,000
Lower Artibonite	381,000	Northwestern Dom. Rep.	137,000
Upper Artibonite	302,000	Northern Dom. Rep.	173,000
Cul-de-Sac Lowland	454,000	La Vega Real	731,000
Southwestern Haiti	769,000	Northeastern Dom. Rep.	77,000
Southeastern Haiti	486,000	Southeastern Dom. Rep.	218,000
Southwestern Dom. Rep.	15,000	Southern Dom. Rep.	483,000

population pressure (Fig. 4). Populations are most heavily-concentrated on the humid plains, particularly the Plaine du Nord, the Vega Real, and the coastal plains around the western part of Haiti's southern peninsula. These three regions have the largest populations on the island, Southwestern Haiti having nearly 770,000, La Vega Real more than 730,000, and Northeastern Haiti more than 540,000, together accounting for about 40 per cent of Hispaniola's total population.

The contrast between the large, closely-settled population regions of Haiti and the smaller, more sparsely-settled regions of the Dominican Republic is evident (Fig. 4 and Table I). The region of smallest population in Haiti, the subhumid northwest, has a total that is larger than those of all but three regions in the Dominican Republic; moreover, the region's areal extent is only a little larger than that of the smallest region in the Dominican Republic.

URBAN AND RURAL SETTLEMENT

A second contrast between the distribution of population in Haiti and in the Dominican Republic is seen in the ratio of urban to rural settlement. Although the 1950 censuses in both countries do not record the urban-rural ratios, percentages can be calculated from the census returns by minor civil divisions. These ratios can be deduced because of the common occurrence of only one urban concentration within each commune. Using the criterion of a town of 1000 or more inhabitants being classed as an urban center, the urban-rural percentages shown in Table II were calculated.

Haiti as a whole is 11 per cent urban, having nearly 350,000 inhabitants in towns with 1000 or more; the Dominican Republic is 23 per cent urban, with

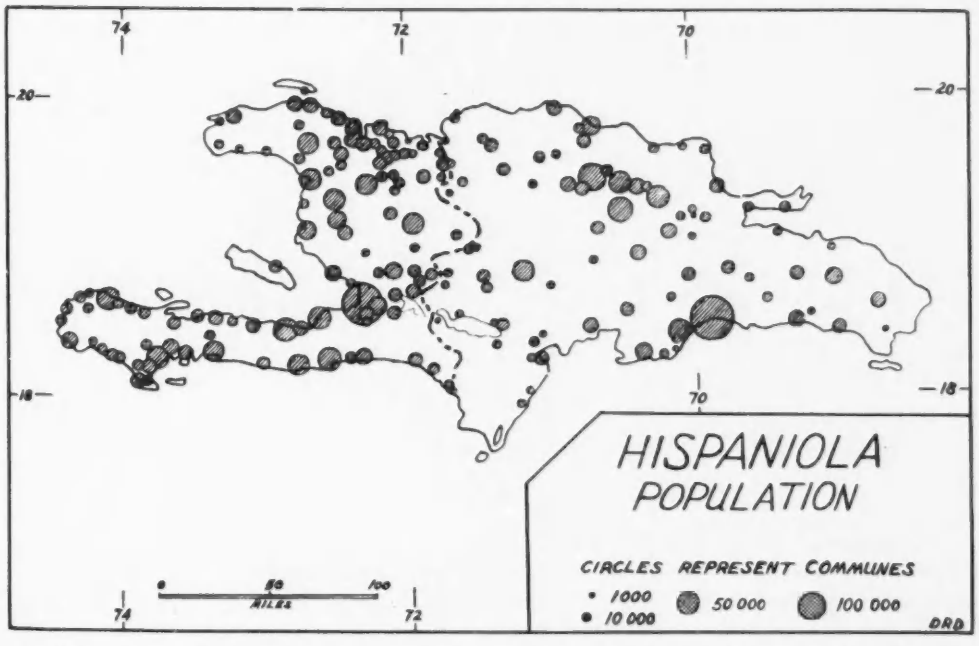

FIG. 4. Areas of most heavily-concentrated population are the humid plains of northeastern Haiti, northeastern Dominican Republic, and southwestern Haiti. Areas of sparsest settlement are the rugged mountains and the arid valleys of both countries.

nearly 500,000 urban dwellers in 1950.[3] Neither country can be described as predominantly urban, in spite of the fact that the percentage in the Dominican Republic is twice that in Haiti. In fact, both are overwhelmingly rural, particularly when one considers that in both countries between one-third and one-half of the total urban population is concentrated in the national capital. Port-au-Prince's 142,840 is 42 per cent of Haiti's urban population, and Ciudad Trujillo's 181,533 is 37 per cent of that of the Dominican Republic.

The Dominican Republic is certainly more a country of urban concentration than is Haiti. This is illustrated by the fact that the national capital is larger and that the Dominican Republic has more large towns and cities. Specifically, the Dominican Republic has 16 towns and cities with 5000 or more inhabitants, whereas Haiti has only 10 (Fig. 3). This point is further emphasized by the fact that the second largest city in the Dominican Republic, Santiago, has a population of 56,192, whereas the second largest in Haiti, Cap-Haitien, has only 24,957. Both of these latter two cities are located in the northern, more humid portions of the island, whereas the capital cities are located in the southern, drier parts.

Other major centers of population on Hispaniola are Gonaïves (13,534) and St. Marc (10,485), port cities in the lower Artibonite region; Les Cayes (11,835) and Jérémie (11,138), port cities in southwestern Haiti; Barahona (14,690), port city in southwestern Dominican Republic; San Juan de la Maguana (10,093) in western Dominican Republic; Puerto Plata (14,419), port city in northern Dominican Republic; San Francisco de Macorís (16,152) and La Vega (14,445) in the Vega Real; San Pedro de Macorís (19,994) and La Romana (11,587), port cities in southeastern Dominican Republic; and Baní (10,048), west of Ciudad Trujillo. From this enumeration of all cities with 10,000 or more inhabitants, one can ascertain a fairly widespread pattern of regional centers. Not all of the 16 population regions has a large city and some regions have more than one; but such an idealized regionalism does almost exist.

[3] If the figure for minimum urban population as used by the U. S. Census—namely 2500 inhabitants—were used to calculate urban populations in this study, Haiti's urban percentage would be 9 and the Dominican Republic's 21.

TABLE II

URBAN VERSUS RURAL POPULATION IN THE SIXTEEN REGIONS OF HISPANIOLA

Region	*Urban*	*Rural*	*Number of Centers with 1000 or More Inhabitants*
Northwestern Haiti	6.0%	94.0%	3
Northeastern Haiti	10.6	89.4	19
Lower Artibonite	9.4	90.6	6
Upper Artibonite	5.3	94.7	8
Cul-de-Sac	34.7	65.3	5
Southwestern Haiti	5.6	94.4	14
Southeastern Haiti	4.5	95.5	6
Southwestern Dom. Rep.	22.1	77.9	2
Hoya de Enriquillo	27.9	72.1	9
Western Dom. Rep.	10.4	89.6	5
Northwestern Dom. Rep.	15.7	84.3	7
Northern Dom. Rep.	8.7	91.3	2
La Vega Real	16.4	83.6	13
Northeastern Dom. Rep.	19.5	80.5	5
Southeastern Dom. Rep.	20.1	79.9	5
Southern Dom. Rep.	44.3	55.7	9

POPULATION ALONG THE INTERNATIONAL BORDER

A final, and a very interesting, aspect of population distribution on Hispaniola is the pattern of distribution immediately adjacent to the international border. In places the boundary lies along a stream course, and in others across a mountain ridge. Generally, where the boundary extends across a mountain ridge the population is sparse, but where it follows a stream course the population is densely-settled on both sides of the river. Many writers

have pictured the intense pressure that has been built up on the Haitian side due to the large population confined to a smaller area than in the Dominican Republic; whereas the Dominican side has been pictured as a nearly vacant space awaiting the overflow from the Haitian side. Possibly an exaggerated view of differences in population pressure between the two sides of the international boundary had some justification in earlier times, but a number of changes have occurred.

Although the picture of the Haitian side of the boundary cannot be reconstructed statistically for an earlier time, the distribution of population along the Dominican side of the border for 1935 can be. The number of Dominican provinces immediately adjacent to the border in 1935 was 3; in 1950 there were 5 provinces, indicating in part the increased emphasis upon settling the frontier from the Dominican side (Fig. 5). Two of the old provinces, Montecristi in the north and Barahona in the south, still touch the Haitian border; but Azua in the center has been divided into three provinces and the original name now applies only to the easternmost portion of the old province. The two new provinces created from Azua were Benefactor, established in 1938, and San Rafael, created from the western part of Benefactor in 1942. The old province of Barahona suffered a like fate to that of Azua, except that a part of Barahona, the southernmost section, still touches the Haitian boundary. The western part of Barahona within the Hoya de Enriquillo lowland was established as Bahoruco province in 1943, which in turn has been subdivided so that the western part is now contained in Independencia province. In the northwestern part of the country Montecristi province still touches the border just south of the Bahía de Manzanillo, and the southwestern part of old Montecristi province has been established as Libertador province, created in 1938. Thus, the provinces presently adjacent to the Haitian border, from north to south, are Montecristi, Libertador, San Rafael, Independencia, and Barahona. In addition, the new prov-

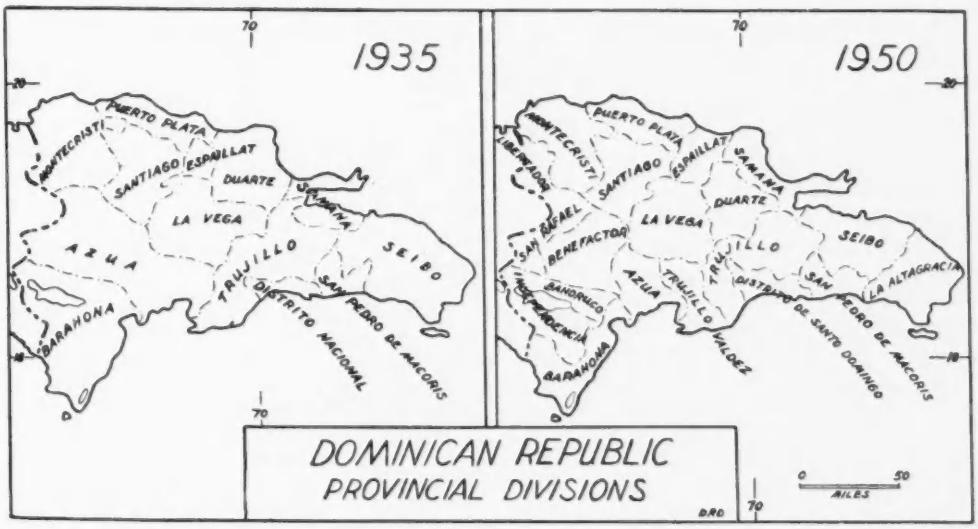

FIG. 5. The increase in the number of provinces on the Dominican side of the international border between 1935 and 1950 indicates in part the policy of the Dominican Republic of trying to build up settlement in their more sparsely-settled territory.

inces of Benefactor and Bahoruco lie behind the recently-established frontier provinces as sort of additional bulwarks.

POPULATION CHANGES ON THE DOMINICAN SIDE

In terms of changes in population distribution along the frontier since 1935, it cannot be said that there has been a rapid and universal increase in population all along the border. It has been true, however, that the attempts to stimulate settlement on the Dominican side by the creation of new political units has resulted in marked increases in population in certain sections. The populations in the new provinces of Independencia, inside the Dominican border in the Hoya de Enriquillo lowland, and of San Rafael, in the upland valleys of the Dominican tributaries to the Artibonite River, have nearly doubled since 1935. Population also has increased in the plains section at the northern end of the border. In the rugged border section of the Cordillera Central and in the dry southern mountains and southern coastal plain little change has occurred.

The most striking change in the pattern of settlement on the Dominican side of the border since 1935 has been the increased urban settlement. Whereas in 1935 there was only one town with a population of more than 500 inhabitants within ten miles of the border, there were seven towns in 1950 with more than 500 and an additional three with nearly 500 inhabitants. The largest town within 10 miles of the border in 1935 was Dajabón (pop. 1103) on the northern plain; the largest town in 1950 was Pepillo Salcedo (pop. 2927) on the south shore of the Bahía de Manzanillo at the northern end of the frontier. Other Dominican frontier towns with more than 1000 inhabitants each in 1950 were Dajabón (1691) and Loma de Cabrera (1417) on the northern plain, Elías Piña (1469) in the interior upland plain, and La Descubierta (1637) in the Hoya de Enriquillo. Probably here are the beginnings of centers that will eventually focus the activities of large population regions.

CONTRASTS ALONG THE BORDER

While settlement on the Dominican side of the border increased somewhat from 1935 to 1950, marked contrasts still were apparent between the two countries (Fig. 6). Although the number of communes touching the border was nearly the same for both sides, the combined populations of such communes were approximately 75,000 on the Dominican side and 250,000 on the Haitian side. Since areal sizes of communes are roughly comparable on both sides, the density of population in Haiti was more than three times as great as the density in the Dominican Republic in the vicinity of the international border. One example of marked contrast in population along the border is in the northern plain at Dajabón and Ouanaminthe along the middle course of the Río Massacre. The 1950 population of Dajabón commune, Dominican Republic, was 8867, and that of Ouanaminthe commune, Haiti, was 31,489. The towns themselves had populations of 1691 and 2378 respectively, again illustrating the higher proportion of urban concentration in the Dominican Republic. Another strikingly contrast was along the R. des Pedernales, which is along the southern extremity of the border. Pedernales commune, Dominican Republic, had 1726 inhabitants in 1950 and l'Anse-à-Pitre commune, Haiti had 10,901 inhabitants (Fig. 6).

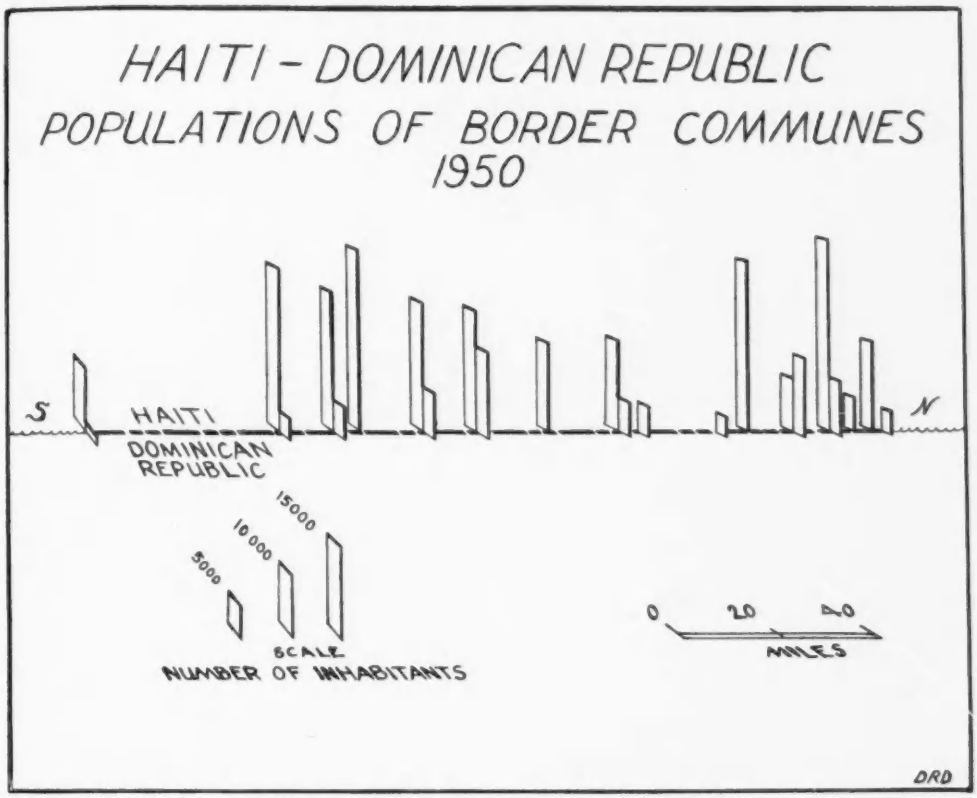

FIG. 6. Populations of communes on the Haitian side of the border far overshadow their counterparts on the Dominican side with only one exception.

CONCLUSION

Since this is the first time that detailed analysis of population distribution in both Haiti and the Dominican Republic has been possible, little can be said about the future on the basis of past trends. On the Dominican side of the border, however, it seems apparent that settlement will continue to be intensified. The development of agricultural colonies particularly, since 1948, whereby nearly 50,000 farmers would eventually own their own land, is well under way and has been concentrated largely in the western part of the country. The government is providing such services as schools, churches, roads, water, electricity, farm tools and machinery, seeds, and technical advice to the inhabitants of each new colony. The terrific pressure of population on the land in Haiti to the point of cultivation of submarginal lands—particularly in the rugged parts of the country—has resulted in such high densities that it seems nearly impossible for densities to increase much in rural areas. Possibly, with the present trends toward emphasis on the production of commercial crops and the beginning of manufacturing, population distribution in Haiti will shift somewhat toward greater concentration in urban centers.

Considering the trends of population increases within the two countries of Hispaniola within the past 30 years, the rate of increase in the Dominican Republic has been one and one-half times

as rapid as in Haiti—an average of 4½ per cent per year in the Dominican Republic and almost 3 per cent per year in Haiti. If—and it is a big "if" in this instance—past trends continue for another 30 years, the total population of the Dominican Republic would be approximately 5,050,000 and that of Haiti 5,900,000 in 1980. Generally, however, as populations become larger their rates of increase tend to slow down and eventually to level off.

SOME FUNCTIONAL ASPECTS OF CAPE TOWN

Peter Scott

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CAPE TOWN, parliamentary capital and second largest city of South Africa, ranks among the oldest permanent white settlements in the southern hemisphere. The modern city, with its population approaching two-thirds of a million, offers a fascinating field for geographical study, partly because of the peculiarities of its topographic and historical growth, partly because of its multiracial character, and partly because of the phenomenal industrial expansion that has taken place since World War II.

The Site

Cape Town stands at the northern end of the Cape Peninsula in the shadow of Table Mountain (3563 ft.). The city core occupies part of the broad amphitheater of Table Valley, flanked on the east by the lofty Devils Peak (3282 ft.) and on the west by the lower elongated mountain shaped like a recumbent lion (Lions Head 2194 ft.; Lions Rump or Signal Hill 1149 ft.). From the shores of Table Bay the land rises gently southwestward to the 100-foot contour, a mile from the sea, and then more steeply to 500 feet. Above this, the gradient rapidly becomes progressively steeper, until the well-nigh vertical sandstone face of Table Mountain is reached. From there, the mountains extend southward for nearly 30 miles in a long narrow mass which varies in width from 3 to 8 miles and finally tapers to the high narrow promontory of Cape Point. Between Table Bay and False Bay the mountains look eastward over the low sandy plain of the Cape Flats, but elsewhere, except for the raised beach on which Sea Point is situated,[1] they slope steeply to the sea.

The early colonists established their farms on the only accessible tracts of relatively level, fertile land: the alluvial soils of Table Valley, the lower clay-covered slopes of the Devils Peak, and the granitic soils to the south, long famous for their vineyards. The Cape Flats, sterile and ill-drained, merely furnished fuel, until, denuded of vegetation, they became a waste of drifting sands and a formidable obstacle to communication inland. They were only reclaimed by the planting of Australian wattles late in the nineteenth century. Today, the urban area, bounded by the 500-foot contour from Fresnaye to Claremont, extends some five miles eastward onto the Flats.

Historical Background

Table Bay was visited by ships of four nations for more than a century before its advantages were sufficiently appreciated for settlement to be attempted. Although exposed to strong northwesterly gales in winter, Table Bay was sheltered from the southeasterly gales

[1] S. H. Haughton: "The Geology of Capetown and Adjoining Country," *Geol. Surv. Mem.*, Pretoria, 1933.

of summer, and, unlike some other Cape bays, Table Valley possessed an abundance of perennial fresh water and cultivable land. The first settlement, founded by Van Riebeeck in 1652, comprised a mud-walled fort built just southwest of the present railway station and vegetable gardens laid out on the site of the present public gardens beyond the southwestern end of Adderley Street (Figs. 13 and 20). The settlement was designed merely to supply passing ships of the Dutch East India Company with fresh produce; it was not at first intended to be permanent. Nevertheless, despite reprimands from the Company,

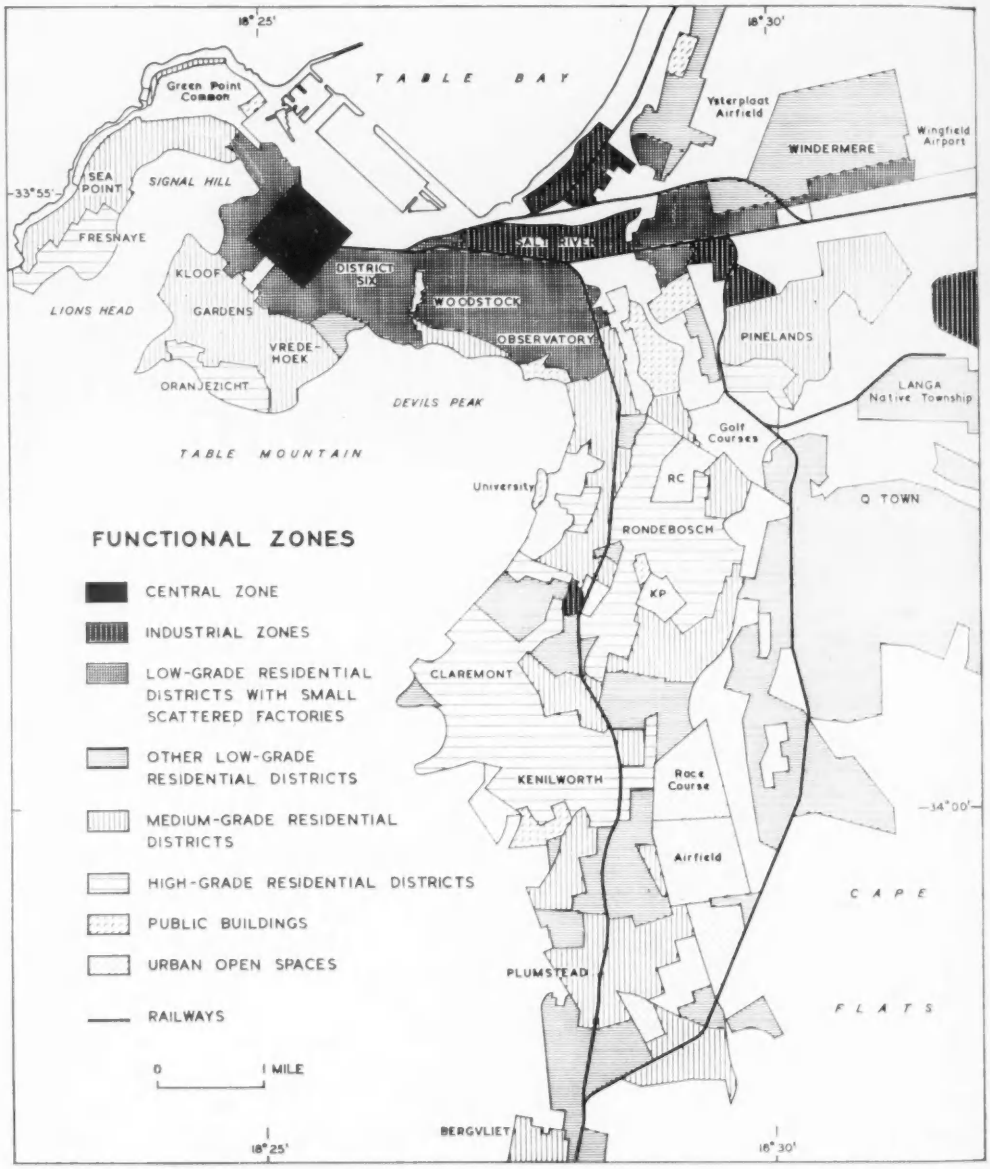


FIG. 1. Functional zones of Greater Cape Town, based on field observation. The central zone merely indicates the location of Figures 13–20. Industrial zone in the map center is the brewery. RC = Rondebosch Common; KP = Keurboom Park.

FIG. 2. Cape Town with Sea Point in the foreground. Sea Point is flanked by the Lions Rump on the left and the Lions Head on the right. Beyond is Table Valley with the Devils Peak in the background and Table Mountain on the right. (Photograph by *Cape Argus*.)

Van Riebeeck laid out a town on a grid plan that was to dominate the urban pattern until the nineteenth century. After 1666, following war between Holland and England, the fort was replaced by the present Castle. By the turn of the century, the European population numbered a thousand, slaves (mostly Malays) totalled nearly 400,[2] several large farms had been established in Table Valley, and farming settlement had spread southward to Wynberg and eastward across the Cape Flats to Paarl and Stellenbosch.

The growth of Cape Town in the eighteenth century falls into two distinct periods: the first half-century was a period of slow growth, due to the steady decline of the Dutch East India Company and to repeated European wars; the latter half was one of substantial prosperity, despite the rapid decline of the Company, declared bankrupt in 1794, and wars in Europe and the East. In the early decades, the Company had still discussed whether or not a town should be allowed to develop, but by the closing decades, Cape Town, as it then began to be called, had ceased to be dependent on the Company's trade. The prosperity of the late eighteenth and early nineteenth century has left behind a rich heritage of architectural beauty. In 1804 the settlement was at last officially recognized as a town. By then, villages had developed at Salt River and Mowbray (immediately south of Observatory) and a hamlet at Rondebosch.

Meanwhile, in 1795, during the Napo-

[2] P. W. Laidler: "A Tavern of the Ocean," Cape Town, 1952, p. 204.

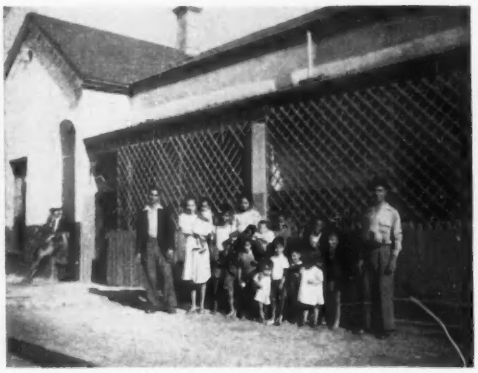


FIG. 3 (upper left). Terrace houses at Salt River occupied by Cape Coloureds.

FIG. 4 (upper right). Two-roomed quarters for married Africans at Ndabeni Street, Langa. In the foreground is the equipment used for brewing kaffir beer.

FIG. 5 (lower left). Lower middle class European house at Mowbray.

FIG. 6 (lower right). Cape Coloured house in the slums of District Six.

leonic wars, the British had occupied the Cape, but in 1803, under the Treaty of Amiens, they returned the Colony to the Dutch. In 1806, however, on the resumption of hostilities, the British again took the Colony, which was formally ceded to Britain in 1814.

Thereafter, until 1870, the prosperity of the Cape Colony depended entirely on its agriculture. Fed by a steady stream of immigrants, Cape Town developed as the port and commercial center of the Colony, and only late in the period, when wool became the chief export, was her supremacy seriously challenged by Port Elizabeth and East London. The steady growth in population resulted in the urban pattern becoming, for the first time, irregular. Most of the large farms in Table Valley were mortgaged by 1820,[3] and those nearest the town were subdivided as the urban area spread toward the mountain and southeastward from the Castle. In 1822 the Heerengracht (now Adderley Street—see Fig. 15) was still the most fashionable residential area, though shops had begun to appear, but by 1865 Adderley Street had become the main shopping area and the Gardens the fashionable residential locality.[4] District Six was then occupied mainly by recently-arrived European immigrants.

[3] *Idem:* "The Growth and Government of Cape Town," Cape Town, 1939, p. 376.

[4] *The Cape Town Directory for 1865.*

In 1865 the European population amounted to 20,966 and the non-European 17,825. These figures include the populous suburbs, several hundred strong, at Wynberg (an aristocratic Anglo-Indian locality), Rondebosch, Mowbray, Green Point, and Sea Point.

The next 40 years, particularly the years 1891–1904, witnessed the greatest expansion in the history of Cape Town; the total population multiplied nearly fivefold. The discovery of copper in 1850, of diamonds in 1867, and of the Rand gold in 1886 brought such trade and wealth to the town that its prosperity was scarcely affected by the opening of the Suez Canal in 1869. Increased maritime trade stimulated improvement of the port. In addition, railways were built first to Kimberley and later to Johannesburg, giving the Cape Colony a temporary monopoly of all mining traffic, but the resultant boom was short-lived and depression followed. Two subsequent booms, each succeeded by depression, marked the remainder of the period, which, in general, was one of unparalleled expansion. During booms, speculators carried out an erratic and premature subdivision of land, which has left its indelible mark on the urban pattern. Ribbon development took place along the old roads and the new railways radiating out from the center, which today have to carry both local and through traffic and perform neither function satisfactorily. In subdivided areas a grid plan was introduced which frequently took no account of the topography nor of the adjoining road systems. Moreover, subdivision on the Cape Flats, where low-lying land is often flooded in winter, has posed serious drainage problems.

The post-Boer War depression from 1903 to 1909 brought about an exodus from Cape Town to the Transvaal; the European population fell from 103,887 to 85,442 in seven years (cf. non-European increase from 65,754 to 76,137). Since Union in 1909, however, when Cape Town became the parliamentary capital and the seat of the provincial government, industrial development has stimulated population growth, strikingly so in the years immediately following the First and Second World Wars. In 1951 the population of Greater Cape Town totalled 632,987, of whom 267,212 were Europeans, 249,098 Cape Coloureds, 59,893 Africans, 48,547 Cape Malays, and 8237 Asiatics, mostly Indian traders.[5]

FIG. 7. Sea Point, the Lions Head, part of Table Mountain, and the west coast of the Cape Peninsula. Note the numerous blocks of flats. (Photograph by *Cape Argus*.)

FUNCTIONAL STRUCTURE

The unique pattern of the present city stems mainly from topographic control and ribbon development. Nevertheless, although broken and distorted by the topography, by the location of industrial zones and commercial subcenters, a series of concentric functional belts may yet be distinguished.

At the core lies the central business zone, roughly rectangular in shape. In Figure 1 the area indicated as the central

[5] See K. Buchanan and N. Hurwitz: "The Asiatic Immigrant Community in the Union of South Africa," *Geogr. Rev.*, Vol. 39, 1949, pp. 440–449; and "The 'Coloured' Community in the Union of South Africa," *Ibid.*, Vol. 40, 1950 pp. 397–414.

FIG. 8 (upper left). Postwar European flats at Sea Point with the Lions Head in the background.

FIG. 9 (upper right). Postwar bachelor flats for Africans at Langa.

FIG. 10 (lower left). Main Barracks, Langa, built before World War II for African males.

FIG. 11 (lower right). Cape Coloured tenements at Woodstock.

zone, which merely locates Figures 13–20, includes more than the office and shopping districts. The central zone will be examined in detail later.

To the west, south, and east lies a zone of social deterioration, made up mainly of workers' housing and invaded by warehouses and factories. The dock area, the Malay Quarter on the slopes of Signal Hill, and District Six were built up mainly in the nineteenth century; Woodstock, Salt River, Observatory, Maitland (southwest of Windermere), and Brooklyn date mainly from the post-Boer War boom. The public gardens in the city center and Trafalgar Park at Woodstock are the only extensive open spaces, for the zone is almost entirely one of warehouses, factories, and single-storeyed brick terraces (Fig. 3). Although the population in places shows a mixed ethnic distribution, it is mostly European in Brooklyn, Maitland, Observatory, and Salt River, and predominantly Cape Coloured and Malay elsewhere. From the docks to Salt River population densities are the highest in Cape Town; elsewhere they are about average. In recent decades the population has been declining in areas adjoining the city center, but east of Trafalgar Park, despite the invasion of industry, there has been a general increase.

The second belt, consisting of medium-grade housing, extends from Sea Point, through the Kloof, the Gardens, Vredehoek, the Devils Peak Estate in upper

Woodstock, and the western or upper parts of Mowbray and Rondebosch, to the garden city of Pinelands. Apart from the Cape Coloured estate in Woodstock and some of the older parts of Mowbray and Rondebosch, this zone is almost wholly occupied by Europeans. Average population densities and average rates of population growth are recorded. The belt is cut off north of Pinelands by the Salt River and, farther north, the Paarden Eiland industrial zones, which together form a separate nucleus surrounded by workers' housing. Sea Point is both a residential area and a tourist resort; it contains not only numerous blocks of flats but also no less than 59 of the 175 hotels located in the area mapped. Table Valley alone has 68 hotels, while the far more extensive residential areas lying east of Table Valley have only 48. This belt also includes the University and many of the schools which have made Cape Town the unrivalled educational center in South Africa. An interesting concentration occurs in the Gardens where a single square mile contains a score of schools and the commerce buildings of the University. The main activities of the University were transferred in 1928 to new buildings next to the zoological gardens on the eastern slopes of the Devils Peak (Fig. 12). Below the University lies Groote Schuur, formerly the home of Cecil Rhodes and now the official residence of the prime minister, while below Groote Schuur lies Westbrooke, the official summer residence of the Governor General.

The third belt is characterized by high-class single-family European homes, separated into well-defined zones by extensive tracts of private and public open spaces and by commercial subcenters, such as Claremont and Wynberg, with their associated zones of low- and medium-grade non-European housing. The belt includes Fresnaye, Oranjezicht, and much of Rondebosch, Claremont, Kenilworth, and Wynberg. Modern luxury flats are typical of the main road through Kenilworth and Wynberg. The only non-Europeans are employees, mostly domestic servants, resident on European premises. Everywhere population densities are well below average, but the population has shown considerable increase in recent decades.

The fourth belt comprises low-grade housing, mostly built since 1930, which extends in a crescent from Brooklyn, through Windermere, Langa, and Q Town, southwestward to Plumstead. Ethnically it is heterogeneous, for Brooklyn is predominantly European, Windermere mostly Cape Coloured but also substantially African, Langa wholly African, Q Town wholly Coloured, and areas to the south are mainly Coloured but contain extensive European tracts and some Africans. For the most part, population densities are comparable to the more favored European zones, but housing conditions present a striking contrast. Windermere, a shanty town of corrugated iron, is undoubtedly the worst slum in Cape Town, but the municipal authorities are building semi-detached houses there to be leased at

FIG. 12. University of Cape Town, with the Devils Peak in the background and Table Mountain on the left.

subeconomic rentals subsidized by the central and local governments. Subeconomic housing schemes have also been established at Q Town and in areas farther south, where many thousand Coloured families are now enjoying not only modern homes in tree-lined streets but such amenities as shops, schools, and playing fields. Langa, a native township built by the municipality in 1922, has a hospital, a clinic, schools, shops, and a restaurant, all run, with few exceptions, by the Africans themselves. The township has a population of 11,000.

The general pattern of residential areas is reflected in statistics of the peak passenger loads carried on the two main suburban railway lines.[6] On the eastern line to Cape Town, which serves such low-grade residential districts as Windermere, Maitland, and Brooklyn, where mainly unskilled and semiskilled workers live, a peak load of 4700 passengers is reached between 7 a.m. and 7.15 a.m. On the southern line, however, which passes through the medium-grade and high-grade residential districts of Plumstead, Wynberg, Kenilworth, Claremont, Rondebosch, and Mowbray, a peak of 4200 is reached between 8.15 a.m. and 8.30 a.m. The smaller peak is due to the far higher percentage of workers from the southern suburbs that travel to the city by automobile.

CENTRAL CAPE TOWN

Cape Town is typical of large cities in that the center exhibits a marked concentration and segregation into districts of business and services. This segregation, however, does not emerge clearly from a comprehensive land-use map, for buildings are predominantly multistoreyed and predominantly multifunctional, a feature accentuated since World War II as a result of a fourfold increase in city land values. Accordingly, following Hartman's technique,[7] individual types of land use were mapped separately in the field during the months April to June, 1952 (Figs. 14–20). These maps provide a basis not only for an accurate demarcation of functional zones (Fig. 13) but also for the more detailed consideration of more types of land use than is normally possible from maps of functional areas. Above all, although an analysis of urban distributions is not the geographer's principal concern, it is vital to an understanding, particularly in such rapidly expanding cities as Cape Town, of the changing functional structure.

Business offices occupy a rectangular-shaped area with extensions southward into residential areas and northward into the warehouse zone bordering the docks (Fig. 16). The offices of banks, stockbrokers, insurance companies, and newspapers, which are particularly sensitive to their location, have been concentrated in St. Georges Street ever since the early nineteenth century, whereas wholesale business offices have undergone marked changes in distribution even during the present century. In 1875 wholesale business was centered around the southeastern end of Waterkant Street, while Loop Street, now the focus of wholesale business, was mainly occupied by early Dutch houses still used as residences.[8] Since then, owing to the areal expansion of financial offices and retail shops, as well as a shift in the warehouse zone resulting from port development, wholesale business has retreated into areas formerly residential. Today, Cape Town serves as a wholesale distributing center mainly for the Western Province, defined as a line extending

[6] *Cape Argus*, May 24, 1952, p. 7.

[7] George W. Hartman: "The Central Business District—A Study in Urban Geography," *Econ. Geogr.*, Vol. 26, 1950, pp. 237–244.

[8] John Noble: "Handbook of the Cape Colony," Cape Town, 1875, p. 34.

from Riversdale through Victoria West to Prieska on the Orange River.

Retail shops are concentrated in four streets: Adderley and Plein Streets, both important shopping areas a century ago, and Long and Waterkant Streets, both of more recent development (Fig. 15). St. Georges Street, important for shops in 1865, contains comparatively few shops today. The high-grade shopping area is Adderley Street, where large city stores occupy several floors of buildings, notably in the central section near the suburban railway station. Southwestward the upper floors become increasingly occupied by offices and northeastward by hotels; at the northeastern end shops give way to cinemas. Both Plein Street to the southeast and the northeastern half of Long Street to the northwest are medium-grade shopping areas, where city stores and large furniture shops intermingle with numerous small shops. The southwestern section of Long Street is a low-grade shopping area, made up entirely of small residential shops. Waterkant Street specializes in the sale of automobiles. City shops also occupy the ground floors of some buildings in the southeastern office zone, while neighborhood shops are scattered throughout the residential and warehouse zones surrounding the commercial core.

Warehouses are mostly confined to two distinct zones: one lies north of the commercial core and serves the wholesale distributing trade; the other lies south of the commercial core and serves the retail distributing trade (Fig. 17). In 1875 the northern zone was centered farther south, close to the jetty situated beyond Adderley Street. Since then, the expansion of the commercial core, together with the development of a modern port, has caused the main zone to migrate northward. The southern zone is essentially a feature of the present century. Warehouses also occur in peripheral residential areas, in the wholesale business zone, and to a very slight extent in the southeastern office zone. They are markedly absent from shopping zones.

Factories and workshops have likewise invaded poor residential areas (Fig. 18). In general, however, they occur farther from the center and mostly to the south and east (Fig. 27). Industries include printing, automobile repairs, food processing, furniture and garment manufacture. This development of industry south of the commercial core, yet largely dependent on the docks to the north, has aggravated the transcity traffic problems arising from the seventeenth and eighteenth century street plan and later unplanned growth. Only three of the many southeast-northwest streets are sufficiently wide today for two-way traffic.

The southern warehouse and factory zone is separated from the commercial core by a remarkably homogeneous east-west belt of public buildings (Fig. 14). This belt may be divided into three zones: the important group of public buildings extending southwestward from the commercial core; the group of municipal government buildings which includes the City Hall; and the Castle. The first zone, which contains many of the finest and oldest buildings in Cape Town, includes the Houses of Parliament and associated government offices, the Provincial Administration Building, the Old Supreme Court Building, St. George's Cathedral, the Groote Kerk, and the South African Public Library (Fig. 23). Other public buildings, such as museums and art galleries, are scattered throughout the commercial core.

Significantly, residences are completely absent from the southeastern office zone centered on St. George's

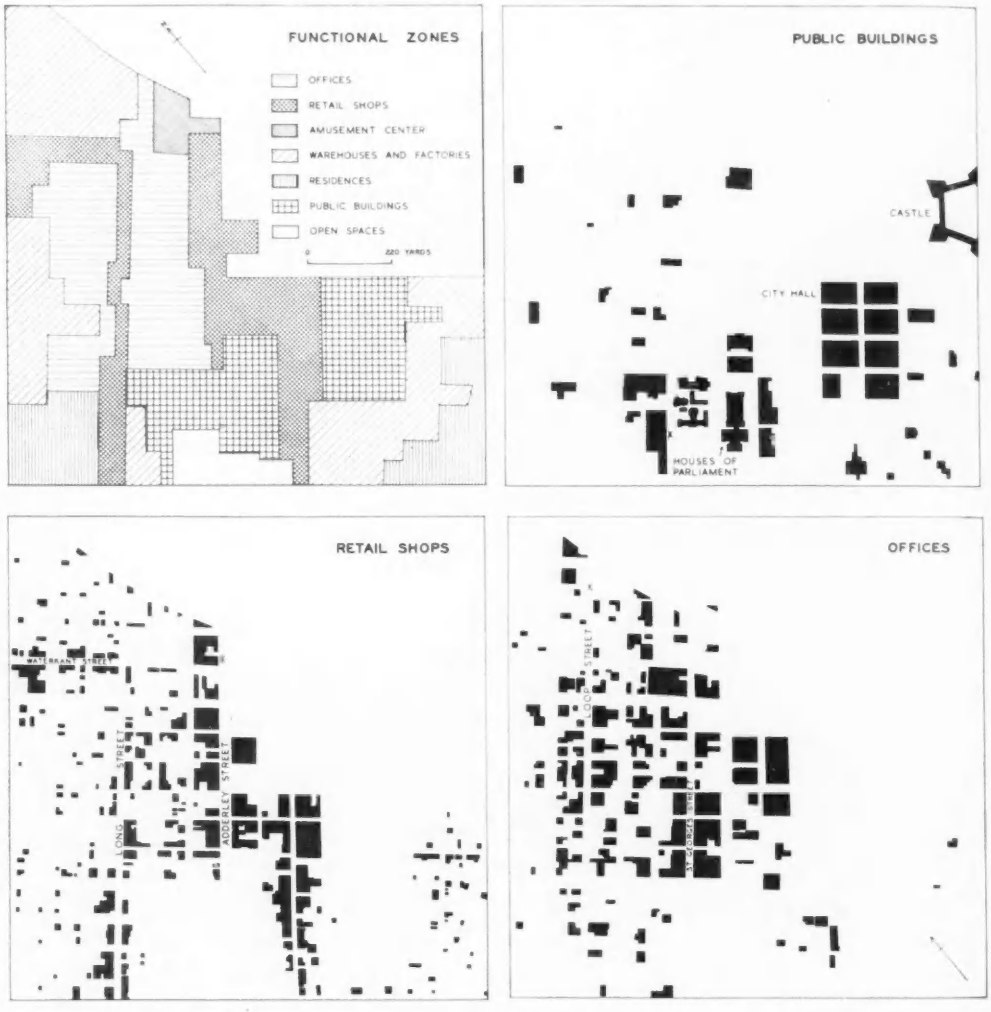


FIG. 13 (upper left). Functional zones of central Cape Town, based on a field survey from which Figures 14–20 were also drawn.

FIG. 14 (upper right). Public buildings in central Cape Town. The X indicates the point from which Figure 23 was taken.

FIG. 15 (lower left). Retail shops in central Cape Town. The X indicates the point from which Figure 22 was taken.

FIG. 16 (lower right). Business offices in central Cape Town. The X, as also in Figures 17 and 19, indicates the point from which Figure 24 was taken.

Street, from the high-class shopping zone centered on Adderley Street, from virtually all the medium-grade shopping area of Plein Street, and from the zone of public buildings (Fig. 19). Scattered residences occur, however, in the northwestern zone of wholesale business offices, in the Waterkant Street and Long Street shopping zones, in the southern warehouse zone, and to a lesser extent in the northern warehouse zone. The predominantly residential belt surrounding the city center adjoins not only the two warehouse zones but also the southwestern fringe of the commercial core. This emphasizes the

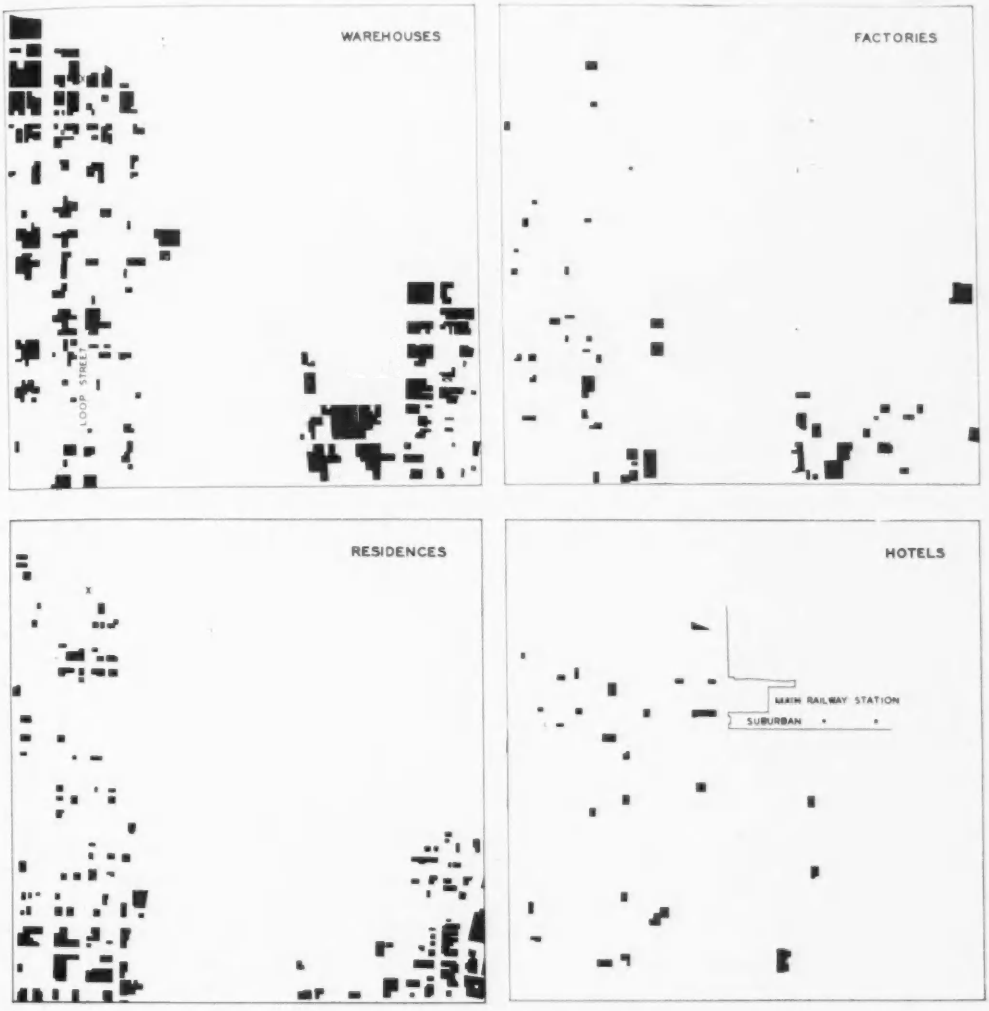


FIG. 17 (upper left). Warehouses in central Cape Town.
FIG. 18 (upper right). Factories in central Cape Town.
FIG. 19 (lower left). Residences in central Cape Town.
FIG. 20 (lower right). Hotels in central Cape Town.

importance to warehouses and industry of location either near the docks or near the main roads and railways leading from the city center inland.

Hotels catering for visitors are located mainly on the roads extending from the railway station into the commercial core (Fig. 20). Some residential hotels occur to the southwest, but even these are located mainly in shopping and office zones. There are no hotels in the northern warehouse zone, nor in the warehouse, industrial, and low-grade residential zones south and southeast of the center.

The functional pattern of central Cape Town may be summarized by indicating the sequence of land use along lines drawn westward, northward, and southward from the railway station. Westward through the heart of the city the sequence is high-class

FIG. 21. Central Cape Town, looking south, with the public gardens on the right and District Six in the left background. (Photograph by *Cape Argus*.)

shops, newspaper and financial offices, medium-grade shops, wholesale business offices, warehouses and factories, and residences. The sequence northward is similar, except that cinemas and hotels replace newspaper and financial offices and medium-grade shops. Southward a representative sequence is less easily selected, for public buildings and open spaces have complicated the pattern, but in general the sequence is high-class shops, medium-grade shops, public buildings, warehouses and factories, and residences.

THE PORT

The Cape Town docks, situated north of the main warehouse zone, constitute the largest artificial harbor in South Africa. There are two basins: the extensive, deep-water Duncan Dock, capable of accommodating the largest ships afloat; and the much smaller Victoria Basin. Completed in World War II, Duncan Dock measures 6000 feet by 2000 feet, covers 290 acres, and has a minimum depth of 40 feet. It includes at its southeastern end the Sturrock Dock, largest graving dock in the southern hemisphere. Victoria Basin, also equipped with a graving dock, covers 67 acres with an average depth of 34 feet. The basin entrances are sheltered from the northwesterly gales of winter by a half-mile breakwater.

A major activity of the port, arising from its location at great ocean crossways, is the provision of bunkers, stores, and water; it accounts for one-third of all cargo shipped. In World War II, when the Cape route to the East carried much of the traffic which normally passes through the Suez Canal, the docks were frequently congested. Vessels docking in early morning for bunkers, stores, and water often had to unberth the same evening to allow other ships to take their places. The harbor has berthing accommodation for 14 large ships, but often handled 20 ships a day. In all, nearly 15,000 merchant ships with a gross tonnage approaching 80 millions, together with 1250 warships

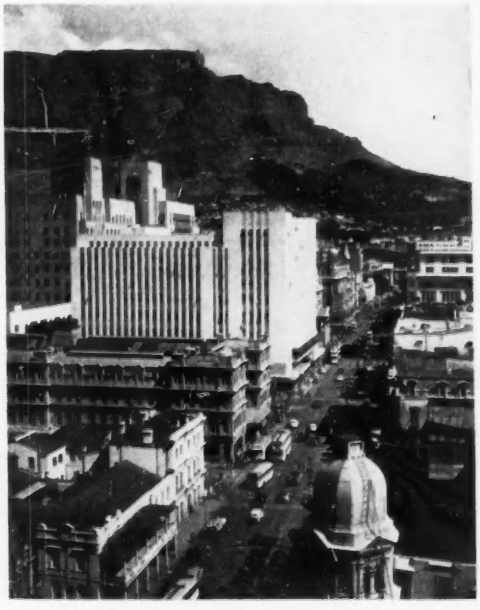


FIG. 22. Adderley Street, with a postwar departmental store and office block in the center. Behind it is the post office and, to the right, the tallest building in Cape Town, an office block 275 feet high. On the edge of Table Mountain is the upper cableway station. (Photograph by Cape Peninsula Publicity Association.)

with a gross tonnage of 4.6 millions, were dealt with in the war years.

Even in peace time, Cape Town handles more shipping than any other South African port. This arises not only because Table Bay is a focus for important seaways but also because it is the nearest Union harbor to the Americas and Europe and therefore the principal passenger and mail terminus. Cape Town also serves as an advanced base for much of the Antarctic whaling fleet, and many catchers winter there while factory ships return to Europe. Victoria Basin is also the base from which most of South Africa's trawling fleet operates. In 1951, Cape Town handled 3630 of the 9747 vessels arriving at Union ports, representing a net tonnage of 8,619,157 out of a total of 24,380,611.[9]

In tonnage of cargo handled, however, Table Bay ranks second to Durban, owing to the longer haulage and steeper gradients on the railway from Cape Town to the Transvaal than from Durban. Nevertheless, Cape Town alone handles two-thirds of all South African exports by value, primarily because it handles bullion exports which are not sensitive to railway freight rates. Aside from bullion, the largest single export from Table Bay, accounting for three-fifths of the total tonnage, is deciduous and citrus fruit grown in the Western Province. The harbor is specially equipped for the pre-cooling and handling of fruit, the fruit stores are among the largest in the world, and loading can be effected from four berths simultaneously. Fruit is destined almost wholly for the United Kingdom. General cargo accounts for one-fifth of the exports, followed by "ores and other minerals," mainly Namaqualand copper exported to the United States and Great Britain. Other shipments of primary products include wool, hides and skins, and wattle bark and extract. Imports are normally twice the tonnage of exports, imported general cargo alone equalling the total exports and oil fuel furnishing some two-fifths of the total. The rest comprises timber and grain.

FIG. 23 (left). Public buildings in central Cape Town, looking from the South African Public Library in the foreground to the Castle in the center background. Behind the library are the Houses of Parliament and in front of the Castle the clock tower of the City Hall. St. George's Cathedral is in the left center with the white-faced Old Supreme Court Building, originally designed as a slave market, beyond. On its left is the Groote Kerk. (Photograph by *Cape Argus.*)

FIG. 24 (right). Loop Street, looking southwest from the point indicated by an X in Figures 16, 17 and 19. In the background is Kloof Nek between Table Mountain and Lions Head. (Photograph by *Cape Argus.*)

[9] South African Railways and Harbours: "Report of the General Manager of Railways and Harbours for the Year ended 31st March, 1951," *U.G. 60/1951*, Pretoria, p. 194.

INDUSTRY

Imported raw materials have been the main basis of industrial development, so that most factories are concentrated along the roads and railways leading from the port to the inland markets. There are three main industrial zones, each located near workers' housing: Ndabeni, the oldest, lies between Windermere and Observatory; Paarden Eiland, made possible by the reclamation of marshland and now perhaps the most popular among industrialists, lies north of Salt River and west of Brooklyn; Epping, a development since World War II, lies between Windermere and Langa. In addition, railway workshops occupy an extensive tract at Salt River, and small factories are scattered throughout the belt of poor housing surrounding the city core. In recent years, factories have tended to move inland away from this congested belt.

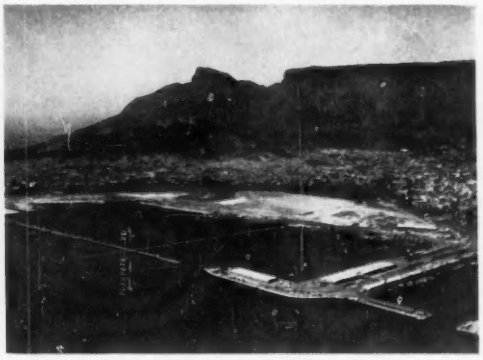


FIG. 25 (left). Amusement and hotel center of Cape Town with the railway station on the left. (Photograph by *Cape Argus*.)

FIG. 26 (right). Cape Town harbor and the reclaimed foreshore (Photograph by South African Railways.)

Figure 27, based on a street-to-street survey, shows the distribution of industries. It illustrates strikingly the large number of small factories in the predominantly residential zones south of the docks and the comparatively small number of large factories in the wholly industrial zones east of the docks. Although it was not possible to determine, by observation alone, the function of all industrial establishments, it was found that Ndabeni contained mainly those industries manufacturing building materials, clothing and textiles, and chemicals, while Paarden Eiland specializes in engineering and food-processing industries. Epping revealed a variety of industries, including the manufacture of packaging materials and metal goods as well as industries already mentioned.

Although Cape Town ranks second only to the Rand among the industrial centers of South Africa,[10] it has remained unimportant for heavy industry, owing to its remoteness from the principal sources of coal and iron, found only in the Transvaal and Natal. Nevertheless, the postwar growth of secondary industry—the value of manufacturing output at the Cape has nearly quadrupled since 1939—has helped to develop engineering industries of all types, ranging from structural steelwork for factory construction to machine repair services. Of particular significance is marine engineering, which includes not

[10] Union of South Africa: "Report of the Department of Labour for the Year ended 31st December, 1949," *U.G. 50/1951*, Pretoria, p. 51.

only ship repairs, notably the repair of whalers on their return from the Antarctic, but also the building of small craft to meet the ever-growing needs of the Union's fisheries. Among the Cape industries engineering ranks fourth in numbers employed and third in the number of establishments.

Clothing and textile manufacture has long been the foremost industry, but an outstanding postwar development has been the manufacture of textiles hitherto not produced in South Africa. Processes include making wool tops, spinning woollen and cotton yarn, weaving, dyeing, and finishing. The high standard of prewar blankets and rugs manufactured at the Cape did much to attract the new industries. Aside from the textile industry, clothing manufacture alone employs about 15,000 workers in more than 125 factories; employees are mostly Cape Coloureds.

Food-processing industries are more numerous than clothing and textile factories but employ fewer workers. Outstanding are the manufacture of jam and the canning of fish, fruit, and vegetables—the only industries which enjoy an important oversea market. Others include the long-established industries of brewing and flour milling and the new industries manufacturing breakfast foods, biscuits, aerated waters, and a wide variety of other foodstuffs. Building and allied industries employ more workers than engineering but have fewer establishments; their products include bricks, made from the weathered clays on the slopes of the Devils Peak, tiles, concrete pipes, plywood, windows, doors, and paints. The leather industry has made remarkable progress in the past decade and now employs 3500 workers, many of them in large, up-to-date footwear factories. Plastics manufacture is also being developed.

Industrial development has been so rapid during the past decade that the consumption of electricity has more than doubled. Power is at present supplied from three steam-driven generating stations, two located near Table Bay docks and one at the Salt River mouth; they have a combined capacity of 318,500 kilowatts. A fourth station is under construction at Salt River, which will have an initial installed capacity of 30,000 kilowatts and an ultimate capacity of 180,000 kilowatts.

Cape Town is also fast outstripping the available water supply. Most of the city derives its water from the Steenbras Reservoir, situated in the Hottentots Holland Mountains some 40 miles southeast of Cape Town above Gordons Bay, but the higher city areas are supplied from five reservoirs on Table Mountain, which have a combined capacity of 533 million gallons (Fig. 27). Steenbras Reservoir was built in 1921 and enlarged in 1937; it has a catchment area of 26.2 square miles, a surface area of 808 acres, and a capacity of 5991 million gallons. The entire supply is taken by Cape Town, where the daily consumption now averages 22 million gallons and reaches 33 million gallons in the dry mediterranean summer. Accordingly, by 1958, a new supply is to be made available from Wemmer's Hoek, situated in one of the highest rainfall areas in South Africa some 40 miles northeast of Cape Town in the Fransch Hoek district.

THE FORESHORE

Perhaps the most interesting aspect of the future development of Cape Town will be the doubling of the central business zone by its extension onto the foreshore reclaimed since 1937 in the construction of Duncan Dock. Adderley Street itself will be extended to the edge of Duncan Dock, making it twice its

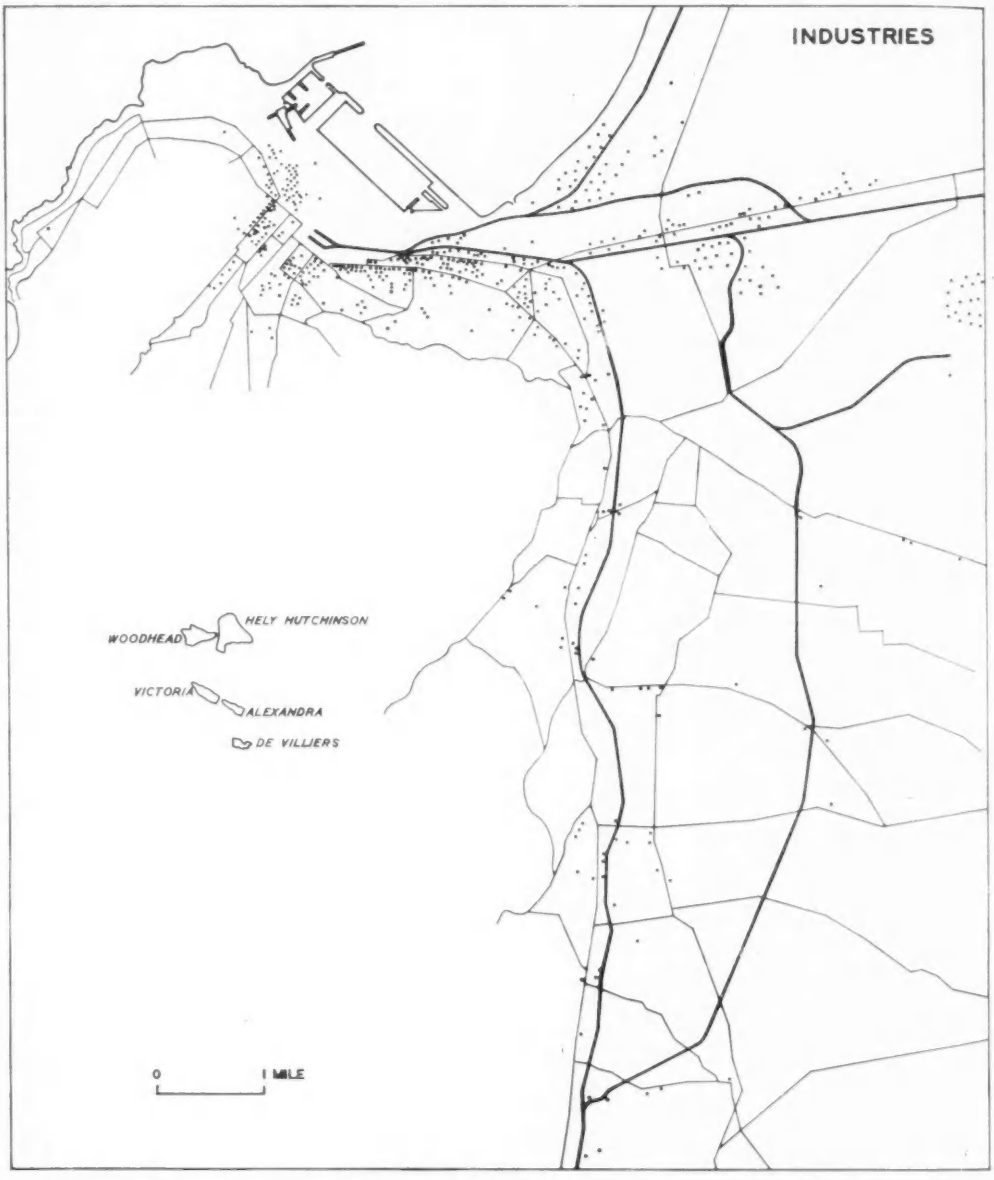


FIG. 27. Distribution of industries in Greater Cape Town, based on field observation. Note the many factories, mostly small, in residential zones south of the docks and the comparatively few factories, mostly large, in industrial zones to the east.

present length. The foreshore plan[11] embodies the creation of a civic center, public gardens, a large luxury hotel, new shopping and office areas, and the re-arrangement of the railway terminus, at present a major obstacle to transcity traffic. Such developments may well call a temporary halt to the decentralization of business offices, factories, and public institutions that has been a feature of the postwar years; it will un-

[11] Cape Town Foreshore Joint Technical Committee: "The Cape Town Foreshore Plan," Pretoria, 1948.

doubtedly affect the spatial arrangement of functions within the existing core. Thus the present survey, undertaken on the eve of such vital and unique changes, not only permits understanding of the contemporary structure but also provides a background against which future changes may be studied in detail.

"CORN BELT" CATTLE FEEDING IN EASTERN COLORADO'S IRRIGATED VALLEYS

David A. Henderson

Mr. Henderson, who is working for his doctor's degree at the University of California, at Los Angeles, studied the Colorado feed lot industry in the field in 1950 and again in September, 1952.

FOR several years the total value of cattle and calves sold alive in Weld County, Colorado (Fig. 1), has exceeded that of any other county in the nation.[1] The spectacular rise in cattle production in this county, and in other irrigated areas in eastern Colorado, is attributable to the intensive use of farmlands for feed crop production and as feed lot bases. Since the middle 1930's the number of cattle on feed in Colorado has increased by over 200 per cent (Table I). Some 15 per cent of this traditional range state's beef cattle were in feed lots on January 1, 1953.[2] Only eight states in the nation, all in the Corn Belt except California, exceed Colorado in the number of cattle on feed. Moreover, the concentration of the pasture and pen fattening industry within circumscribed irrigated areas, gives these Colorado farmlands most of the aspects of a mixed farming Corn Belt economy.

Extending from the wheat and range lands of eastern Colorado westward along the South Platte River, cattle production on irrigated farms increases until it reaches its maximum on the northern Colorado Piedmont (Fig. 1). Here the South Platte River and its eastward flowing tributaries provide abundant irrigation water for the raising of lush pastures and bumper crops of grain and sugar beets used to fatten cattle. Although 88 per cent of the State's feeder animals are located in this northeastern area, almost the entire remaining 12 per cent are found on irrigated farms in the eastern Arkansas River Valley.[3] Although not all the dots in the two feeding areas shown in Figure 1 represent feeder cattle, the intensity of cattle raising in these river valleys contrasts sharply with the diffusion of animals on the surrounding ranges.

Cattle production on Colorado's farmlands is "big business." Passing through the two feed lot areas one sees prosperous farms of moderate size, 80 to 320 acres, many of which, however, boast large modern feeding pens next to the farmsteads. Adjacent to a sugar mill a sea of cattle several thousand in number, feeding in acres of pens, may startle the outsider (Fig. 2). Seldom do

[1] U. S. Bureau of the Census, *Census of Agriculture: 1950.* Vol. V, Special Reports, Part 3, "Ranking Agricultural Counties," Washington, Government Printing Office, 1952, p. 8.

[2] Derived from data in the following sources: U. S. Department of Agriculture Cooperating with the State of Colorado Department of Agriculture, Bur. of Agr. Econs., Colorado Crop and Livestock Reporting Service, "Livestock on Farms: January 1, 1953," Denver, January 16, 1953, pp. 1–2; "Cattle on Feed: January 1, 1953," Denver, January 15, 1953, pp. 1–2; Colorado Department of Agriculture Cooperating with the U. S. Department of Agriculture, Bur. of Agr. Econs., "Colorado Agricultural Statistics, 1950," Vol. 1, No. 2, Denver, January, 1952, p. 87.

[3] Colorado Department of Agriculture Cooperating with the U. S. Department of Agriculture: "Colorado Agricultural Statistics: 1950," p. 89.

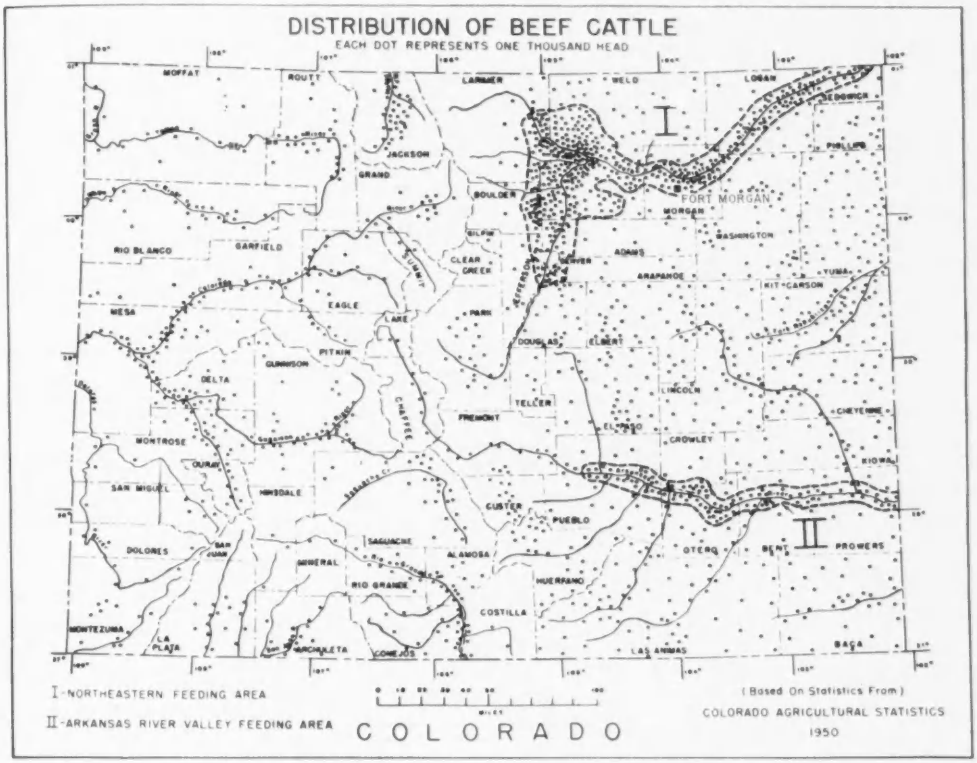


Fig. 1. Colorado cattle feeding areas.

cattle feeders raise as few as a dozen or two dozen steers. In this last respect, the Colorado feeding industry reflects an intensity of production greater than that to the east of the State.

There are several economic reasons for the intensive raising of cattle west of the Corn Belt. The nation's increased demand for beef during World War I pushed production westward into Colorado's irrigated valleys. Since that time, in Colorado, cattle fattening has increased at the expense of lamb feeding. National demand for beef has risen to the point where today per capita consumption is as great as it was at the turn of the century. As a result of the increased consumption of beef, cattlemen's incomes have risen faster than those of lamb producers, and the feeding of cattle has, in large measure, eclipsed lamb feeding in Colorado. Not only national demand, but also western demand, has increased markedly since World War II, resulting in further increases in cattle fattening in Colorado. On account of the economy realized in shipping carcasses of dressed beef by refrigerator car, increases in freight rates east of the Missouri River, and savings in weight loss resulting from long hauls, Denver has become the seventh largest cattle market in the nation, and the largest market outside the Corn Belt.[4] Almost all Colorado fat cattle now move, principally by truck, to the Denver market. The growth of the Colorado cattle feeding industry is indicated by Table I.

In addition to economic reasons, there

[4] U. S. Department of Agriculture, Production and Marketing Administration: *Livestock Market News, Statistics and Related Data*, Statistical Bulletin No. 91, August, 1950 (Washington: 1950), p. 6.

TABLE I

GROWTH OF THE COLORADO CATTLE FEEDING INDUSTRY

(Cattle on Grain Feed for Market, January 1, in thousands)

Selected Years	*Arkansas River Valley*	*Northeastern Area*	*All Other Areas*	*Total*
1928	12	120	8	140
1933	5	65	5	75
1938	8	130	5	143
1943	15	137	8	160
1946	15	153	8	176
1949	22	175	5	202
1951	22	200	7	229
1952	33	260	7	300
1953	30	259	7	296

Figures derived from Colorado Department of Agriculture Cooperating with the U. S. Department of Agriculture, Bur. of Agr. Econs., "Colorado Agricultural Statistics, 1950," Vol. I, No. 2, Denver, January, 1952, p. 89; "Colorado Agricultural Statistics, 1948–1949," Vol. I, No. 1, Denver, January, 1951, p. 80; and U. S. Department of Agriculture Cooperating with the State of Colorado Department of Agriculture, Bureau of Agricultural Economics, Colorado Crop and Livestock Reporting Service, "Cattle on Feed, January 1, 1953," Denver, January 15, 1953, p. 2.

are several natural environmental considerations which foster intensive cattle production in Colorado. Some increase in cattle production has been possible by restoring marginal wheat lands in eastern Colorado to their best use as ranges. However, this increase through extensive production cannot continue to be great because the amount of additional potential range land is limited. The State's mountain watershed ranges have been valued annually at $2.50 an acre as water producers and only $1.00 at most as forage producers.[5] Under heavy grazing, the more important watershed value, water production, declines. Government administrators of these mountain watersheds, therefore, have reduced the numbers of livestock allowed to graze the mountain ranges. Accordingly, the State's mountain and eastern ranges cannot be expected to supply cattle to meet increased beef demand. It is only through intensive production on irrigated pastures and in feed lots that cattle raisers in Colorado can continue to increase the supply of beef.

[5] Derived from data in Izaak Walton League of America, Inc.: "Our Public Lands, Their Administration and Use," Chicago, pp. 13–15; and Rocky Mountain Forest and Range Experiment Station, "Guide and General Information for Range Field Day, Manitou Experimental Forest, September 13, 1950," Fort Collins, Colorado, 1950, p. 6.

CATTLE PRODUCTION IN COLORADO'S FEED LOTS

The Colorado feed lot industry, to which cattle are sent from western pastures and ranges, is large. In the West, only California has comparable numbers of cattle on feed. California's feed lots, which were supporting 327,000 animals on January 1, 1953, utilize the by-products of California specialty crops and are basically a supply response to that State's two large urban markets. On the other hand, Colorado's industry, which was maintaining 296,000 animals on January 1, 1953, and which will market in 1953 about one-third more than this number,[6] is part of a "Corn Belt" mixed farming economy which is evolving in the State's irrigated valleys. The cultural and physical environments of these valleys lend themselves admirably to intensive cattle raising.

There are several cultural factors which contribute to successful cattle feeding in Colorado. A balanced farm economy is attained through cattle production. Cattle fit well into the farmer's work pattern by providing activity in the otherwise idle winter season. Their sale gives the farmer increased income and they provide fertilizer for his crop fields. Crops themselves are fully utilized when waste products are consumed by cattle. Grains and hay grown as cattle feed produce more income as meat than as crops.

[6] Data from "Cattle on Feed, January 1, 1953," p. 2; and Paul W. Swisher, Colorado State Commissioner of Agriculture, Personal Communication, February 16, 1953.

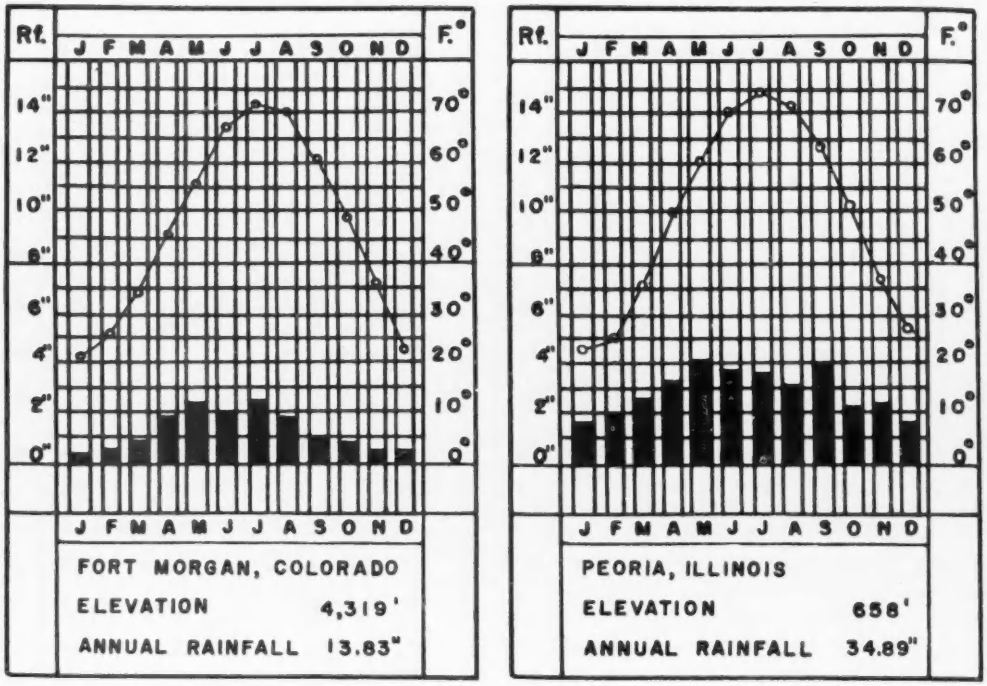
Fig. 2. Large "commercial" feed lot adjacent to a sugar mill in northeastern Colorado.

Fig. 3. Midwinter scene showing dry feeding-pen floor in northeastern Colorado.

With one exception, the crops grown in Colorado as cattle feed are gradually coming to be, as in the Corn Belt, crops grown specifically for feeding. The exception, sugar beets, has for years supplied farmers with a waste product high in fattening carbohydrate: beet pulp. Roughage is provided by the green leaves of the beet-tops. Today, in order to compete with less bulky feeds, beet waste products are being made into pellet and meal concentrates. The supply of beet by-products for feeding is abundant in the eastern Colorado valleys where the beet sugar industry is large. One county in the area, Weld County, led the nation's counties in sugar production in 1949.[7] Barley, adapted as are sugar beets to cool nights, has long been an important grain crop used to fatten cattle in Colorado. In fact, Weld County ranked first among the counties of the nation in barley acreage in 1949.[8] Oats, lower in total nutrients than barley or corn, are used to a lesser degree in cattle feeding. Grain sorghums, not high in total fattening nutrients, were once widely used as cattle feed, but in recent years have decreased in importance as farmers have adopted more nutritious feeding crops. The use of corn in fattening cattle has increased in recent years. Hybrid varieties which are resistant to the State's cool nights are being increasingly planted. Yields up to 50 bushels an acre decrease the farmer's dependence on imported corn.[9] This grain is a desirable feed because it is not bulky compared to dried beet pulp and contains more fattening nutrients than any of the other grains.[10] Almost all farmers raise alfalfa in rotation with other crops. Here again Weld County ranked high among the nation's leading counties, second in alfalfa acreage cut for hay in 1949.[11] As hay, this legume supplies excellent roughage and green feed, essentials in the cattle fattening diet. Protein supplements to the animals' diet, principally soybean and cottonseed derivatives, must of necessity be imported.

Many elements of the physical environment—level terrain, fertile soils, abundant water resources, and adjacent ranges—contribute indirectly to the efficacy of the Colorado feed-lot industry. However, it is climate which directly influences the efficiency of the

[7] U. S. Bureau of the Census, *op. cit.*, p. 39.
[8] U. S. Bureau of the Census, *op. cit.*, p. 28.
[9] Colorado Department of Agriculture, *op. cit.*, pp. 29, 47.
[10] E. J. Maynard: "Beets and Meat," *Through the Leaves*, September–October, 1950 (Denver: Periodical of the Great Western Sugar Company).
[11] *The Greeley Tribune*, Greeley, Colorado, April 21, 1953, p. 1.



FIGS. 4 and 5. Climatic charts for a northeastern Colorado feeding area station and for a typical central Corn Belt station.

industry. As Figure 4 illustrates, the climate during the winter feeding period is cold and dry. This dryness contrasts sharply with the Illinois Corn Belt (Fig. 5). Dry cold itself, in the absence of extremely low temperatures or high winds, is not injurious to the breeds fed, the Hereford and the Aberdeen Angus. Adequate protection from wind is achieved by placing feeding pens on the leeward side of farm buildings. Winter dryness, coupled with abundant sunshine, is an important asset to farmers fattening cattle. No expensive barns are necessary to keep cattle dry. Dirt pen floors which remain dry and free of mud all winter obviate the necessity of concrete flooring (Fig. 3). In regions with humid winters, such as the Corn Belt, animals must either be provided with hard-surfaced pens or left to wallow in mud sometimes knee deep. Cattle, restricted in movement by mud, gain less per day than animals in Colorado's dry feed lots. Dryness and low humidity reduce the incidence of disease. Dry pens are easy to keep clean, thus restricting the spread of filth disease. Low humidity minimizes the danger of respiratory disease.

THE FARMER-FEEDER

Operating within the physical and cultural environmental framework of Colorado's irrigated eastern valleys, there are two rather different kinds of cattle feeders. The small scale operator may be termed a farmer-feeder and the large scale operator a "commercial feeder." About 50 to 200 animals are fed by the farmer-feeder who practices mixed farming very similar to that of the Corn Belt. His operation begins in the autumn when calves and yearlings are purchased off ranges unable to support the cattle through the winter. By

Fig. 6. Cattle belonging to a farmer-feeder foraging on a stubble field during the winter.

this time the farmer's crops with which the cattle will be fed have been harvested.

Although there are hundreds of individual farmer-feeders, their operations are essentially similar. On many farms the cattle are confined in pens only part of the time. At other times they are allowed to roam harvested fields where they forage on piled sugar beet leaves or grain stubble (Fig. 6). When their animals are in the pens, farmers feed the cattle a scientific feed mixture. Roughage (chiefly alfalfa), ensilage (primarily corn), protein concentrates, and beet molasses are some of the items commonly included in the balanced diet. Fattening carbohydrates consist of grains and beet pulp. The pulp is often allotted to farmers by the sugar company on the basis of the amount of beets which were produced on the farm, thus insuring every beet raiser of a certain amount of cattle feed. Corn as a part of the feed mixture has become increasingly important as the planting of hybrid varieties has spread throughout the irrigated areas. On an average, it takes about an acre of crops to support one animal through the 6 or 7 month feeding period.[12] During this time, a yearling steer gains just under two pounds a day or a total of about 400 pounds.[13] In contrast with some Corn Belt areas, almost no cattle are fed as long as a year. Animals fattened that long produce the top grade of beef with a high proportion of fat in the meat, but in western markets there is little demand for this "night club" beef.

The physical facilities employed by the farmer-feeders are not extensive. If ensilage is to be fed, a silo, either above or below the ground, is needed. Steel bins or wooden corn cribs are used to store grains. Pens, which need no expensive concrete floors, are built of wood. Since the cattle roam the fields

[12] E. J. Maynard, *op. cit.*, pp. 36–37.
[13] *Ibid.*, p. 27.

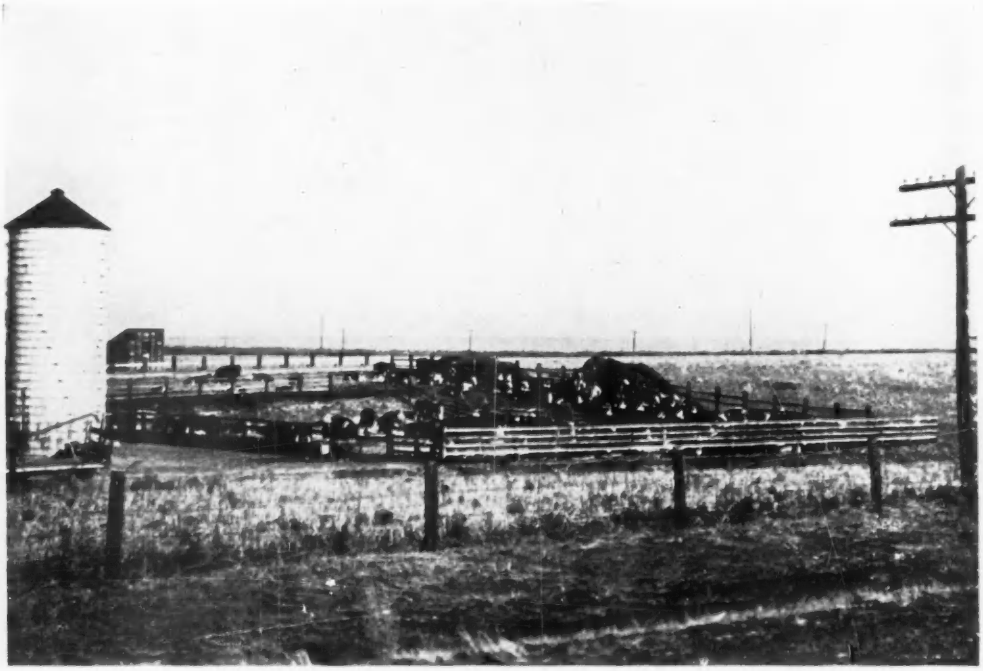


FIG. 7. Small farmer feed lot in northeastern Colorado.

much of the time, space in the pens is not critical and therefore the pens do not cover a large area (Fig. 7). The cattle feeding done by farmers is part of a mixed farming operation and as such utilizes the physical plant, crops, and labor available on the farm.

THE COMMERCIAL FEEDING OPERATION

Commercial feed lots in Colorado are the largest and most intensively operated in the nation. Only those in California rival these gigantic so-called "beef-factories." Commercial feed lots are found in the same irrigated areas as the farmer feed lots, but stand in marked contrast to the latter. Since from 200 to 25,000 animals are fed in individual feed lots each year, the labor, crops, and physical facilities of one farm seldom are adequate to meet the demands of the operation. Often no farming operation at all is carried on in conjunction with the feeding. The largest feed lots are sometimes located adjacent to a sugar refinery (Fig. 2), where wet beet pulp, which is cheap but also heavy and bulky and therefore expensive to transport, can be economically utilized.

In contrast to the autumn and winter operation carried on by the farmer-feeder, the commercial feeding operation takes place throughout the year. Generally, cattle are fed for about six months. Profits are realized from rapid turnover and low cost production techniques. As mentioned before, this process produces lower grades of cattle than those fattened for as long as one year in the Corn Belt. As in the farmer feed lots, calves and yearlings are fattened in the commercial feed lots. However, since the commercial feeders demand so many animals and also demand them at times other than in the autumn when they are shipped from Colorado ranges, cattle must be imported from nearby states to meet

their needs. The warmer areas in the southeast ship many calves and steers into the State during the winter.

Commercial feeding is a somewhat more intensive and efficient business than farmer feeding. Scientific mixtures of essentially the same crops fed by farmer-feeders constitute the diet given the cattle in "commercial" feed lots. However, the proportions of different crops making up the balanced diet and the methods and time of feeding are often worked out more precisely than they are by feeders with small operations. Corn is imported from the western Corn Belt where some of the crop is grown on farms owned and operated by Colorado commercial feeders. The cattle's drinking water is heated in winter because the animals will drink little water and thereby consume less feed if the water is cold. Some commercial feed lots are illuminated by electric lights so that the cattle will eat whenever they feel so disposed throughout the 24-hour day. Thus, commercial feeders usually put more weight on their stock in a given period of time or they feed for shorter periods of time than does the farmer feeder.

The large physical plant employed by many commercial feeders well deserves the title "beef factory" (Figs. 2 and 3). One cattleman in northeastern Colorado has some 60 acres in pens. Many sets of pens containing different groups of cattle at different stages of feeding are included in the commercial lot. Some producers even maintain a special "sick bay" pen. Here, cattle which have contracted the respiratory and digestive diseases characteristic of close confinement and concentrated diets are isolated and treated. The purchase of feed crops before the fattening period begins necessitates the construction of huge silos found adjacent to the pens. However, this practice hedges against crop price rises and thus cost of production changes. Up to 600,000 bushels of feed can be stored in the silos of one northeastern Colorado operator. Next to the silos often stands a large grinding and mixing mill in which the feed crops are combined into a balanced and palatable cattle diet. Trucks in which the feed is delivered to the troughs, night lighting systems, and barns for hay storage are other appurtenances to the commercial feed lot.

Summary and Conclusion

Intensive cattle raising in feed lots appears to have become a permanent adjunct to the irrigated farm economies of eastern Colorado. The postwar expansion of national markets and particularly the growth of western markets for beef has created a strong demand for Colorado fat cattle. The raising of feed crops and the fattening of cattle are, in part, responses to high postwar beef prices. These activities, therefore, might be expected to be curtailed in favor of other crops with a fall in beef prices relative to other commodity prices. Throughout most of 1953 this has been true to a certain degree. However, cattle raising on Colorado farm lands is not marginal, but is a response to favorable supply or cost as well as demand considerations. Therefore, it may be expected to continue in spite of lower beef prices.

Advantages of supply accruing to the Colorado feed lot operator are several. On fertile soils and under irrigation in a semiarid climate, high yields of quality feeding crops provide low-cost cattle feed. These crops are sufficiently diversified to allow the farmer to practice a soil-building crop rotational scheme. Since the crops raised, even by farmers who do not feed cattle, are in large measure feed-stuffs, this produce in the

form of beef increases the income of the farmer who also raises cattle. In feeding cattle, the farmer provides himself with remunerative winter employment and with manure with which to fertilize his fields. Proximity to growing western markets in which cattle are slaughtered for sale as beef in the East and on the Pacific Coast or for growing local consumption is an important reason for the continued growth of the Colorado cattle feeding industry. Other western irrigated areas may well profit in the future by the example of intensive, high income-producing, mixed farming set by eastern Colorado's irrigated valleys.

BOOK REVIEWS

World Population and Production, by W. S. Woytinsky and E. S. Woytinsky. lxxii and 1268 pp.; maps, diagrs., tables, source references, index. Twentieth Century Fund, New York, 1953. $12.00. 10¼ x 7 inches.

This is one of those extraordinary books, where one marvels that anybody can have the energy, not only to collect such a mass of statistical material but also to add to the statistical importance the value of careful evaluation, and a glimpse into the future. It is indispensable to have this book around; in fact now, when we have such a book, it is almost strange to think that we did without it so long.

It is impossible to digest its contents at once. One can only glance through it and then return to the individual chapters whenever a need exists. For a geographer its main value is the comparative study of nations. For instance, tables 188 and 189 give, for most of the countries of the world, per capita income, population characteristics, and consumption (food, industry, and power). These tables alone are a challenge to the geographer to interpret and understand.

For those who do not know the book (and should buy it), let me enumerate the major parts of this tremendous statistical survey of more than 1200 pages. The earth, peoples of the world, migration, cities, births-deaths-marriages-divorces, health, the future of the world population, consumer needs and outlays, consumption and standards of living, natural resources, human resources, abundance and scarcity, economic pattern, agriculture in the world economy, lands, farms and farming, food crops, technical crops, livestock and animal products, forests and forest products, fisheries, mining in the world economy, metallic and nonmetallic minerals, coal, petroleum and natural gas, the economics of energy and power, manufacturing in the world economy, the food-drink and tobacco industries, the textile industry, the iron and steel industry, the machinery and transportation equipment industries, and finally the chemical industry.

For a reviewer it is impossible to give a critical judgment because of the scope and quantity of the material. As with every statistical study, it has the disadvantage of already being out of date at the moment of publication. The world moves fast and regular statistical publications like those of the United Nations are still necessary in order to know what is happening. For instance, petroleum statistics for 1950 cannot be used any more in 1954, if one wants to know the latest developments. However, that disadvantage can be easily overcome.

At times one wonders about some of the information given. Where are the 5 million Buddhists in North America (see table 24)? Hinduism certainly does not prevail in Burma (page 56). Are there major iron ore mining districts in the German Rhine Graben (figure 226)? But those are only very minor incidents in a general impression of deep appreciation that such a wealth of information is compiled and published. Moreover, the book contains a most valuable list of source references. That list alone is worth the price of the book.

S. Van Valkenburg

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How Strong is Russia?, by George B. Cressey. ix and 146 pp.; maps, ills., selected references, index. Syracuse University Press, 1954. $3.00. 8¾ x 5½ inches.

Dr. Cressey's new book is, to a large extent, a condensation and revision of his well-known text, *The Basis of Soviet Strength*. Both volumes deal with the natural landscape, with mineral resources, with Soviet economic accomplishments and plans, and with the geo-political aspects of Russia's power. *How Strong is Russia?* presents its data in a simple, largely qualitative form. Its discussions of settlement patterns in the Yenisei Valley and of selected characteristics of urban centers, discussions following earlier chapters on ethnography and on economic regions, are especially valuable.

"Siberian villages are standardized affairs, where drab log cabins line a single street for as much as a mile. . . . Collectivized agriculture does not seem to have changed the appearance of the village very much. Fields have been merged and are worked cooperatively, but house types and village patterns are about the same as before" (pp. 52–3).

Again, "Every Soviet citizen must have an internal passport. . . . This is partly a police measure; it is also a realistic necessity because of the extreme housing shortages and the desire of many people to move to the larger cities

where wages may be higher. . . . Apartment houses are often owned by the factory. This also provides leverage against workers leaving their jobs, a very common practice in the U.S.S.R., for, on leaving the factory, workers must give up their apartment space, and other accommodations may be impossible to secure . . . " (pp. 66-7).

Throughout the volume, Dr. Cressey has maintained his characteristic objectivity. He has, especially in the discussion of new plans, attempted both to present Soviet viewpoints and to evaluate them dispassionately. On a few points of fact, however, errors have crept in. Thus, the Soviet rural population is given by Dr. Cressey variously as "half" (p. 12) and "two-thirds" (p. 66) of the total; about 60 per cent appears to be the current figure. (G. M. Malenkov in the *New York Times*, August 5, 1953, gives an urban population figure of 80 million.) The population estimates for individual cities (*e.g.*, Moscow, 5 million, p. 68; Riga, 0.5 million, p. 85) seem high. The endpaper map shows the Taishet-Komsomolsk or Baikal-Amur Railroad as completed; so far as I know, little if any part of that line exists. In addition, Soviet maps since 1951 have shown the Vorkuta Railroad terminating on the Ob River, rather than at Kara (see G. U. Geodeziyi i Kartografiyi S.M. S.S.S.R. U.S.S.R. European Part. Polit.-Adm. Map. 1:2.5 million [in Russian]. Moscow, 1952). Errors of caption have not altogether been eliminated, cf. pp. 31 and 49. But all these are minutiae.

In general, *How Strong is Russia?* provides a concise, reliable and objective geographical introduction to the U.S.S.R. It is well organized and well written, emphasizing relations and processes rather than detail. It can be highly recommended for the intelligent general public, and appears ideally suited as an elementary textbook. For more advanced work, it lays a good foundation to which the student should add specialized information: in this regard, the bibliography, on pages 141–142, is most useful. Finally, even the specialist in Soviet affairs can profit from many of the generalizations and judgments: . . . "Most exports bring little economic advantage; instead, they represent a delay in meeting domestic goals. This is certainly the case with almost all manufactured goods; it is normally true of grain, but it is not the case with manganese, gold, or a few other surplus raw materials" (p. 123). The most general conclusion reached by Dr. Cressey is noteworthy: "It is a serious mistake to overlook Russia's assets and the notable achievements of the Five Year Plans; it is equally a mistake to believe that the country holds material resources which might enable it to conquer the world. Communism as an ideology should be considered apart from Russia as a place, but in the unlikely event that Communism commands world wide support, it operates from a weak base so long as it flows from the Kremlin" (p. 140). Though modest in format and succinct in presentation, *How Strong is Russia?* has much indeed to offer.

D. B. SHIMKIN

Washington, D. C.

Report on Industrialisation and the Gold Coast, by W. A. LEWIS. viii and 24 pp., Government Printing Department, Accra, Gold Coast, two shillings six pence. 13¾ x 8¼ inches. 1953.

Industrial Development in Jamaica, Trinidad, Barbados, and British Guiana. Report of Mission of United Kingdom Industrialists (Colonial No. 294), iv and 51 pp., tables and graphs (including folding graphs). Her Majesty's Stationery Office, London, 1953. Two shillings. 9¾ x 6 inches.

Industrialization is widely believed to be the panacea for all the evils from which underdeveloped areas suffer. Unfortunately for the believers in this universal remedy, prospects of industrialization vary substantially from place to place. This is due to differences in natural endowment, accessibility, and the whole complex generally referred to as cultural factors. In addition, there are other spatial phenomena, such as size of an area, distribution and intensity of supply and demand, significance of weights in transportation—which also are important in the processes of industrialization. The significance of these latter factors is well illustrated in the two excellent reports here reviewed, which both deal with tropical areas that have no outstanding specialized natural resources within their territories. The report on the West Indian areas was prepared by a commission of visiting British industrialists for the British Colonial Office; in contrast, the report on the Gold Coast was written for the now self-governing colony by Professor Lewis, a distinguished economist of Manchester (England) University, who is a Negro of West Indian origin. Despite the divergent backgrounds, both reports agree on the principles that condition industrialization, and differ only in details of lesser interest to geographers, e.g., on the application of subsidies.

Lewis distinguishes between industrialization due to the processing of local material resulting in the export of manufactures or semi-manufactures, and industrialization for supplying primarily the local market. A third possibility, industrialization based on imported raw material and export of finished products, following the example of Japan or Puerto Rico, appears to offer no hope for the Gold Coast with its high total labor costs (wages and supervision) which exceed those of many other underdeveloped

areas. Lewis explains this phenomenon by stating that "the Gold Coast is not overpopulated" (p. 3). However, on the overpopulated West Indian islands similar high total labor costs can be observed, and copying the thoroughly discussed Puerto Rican "Operation Bootstrap" also is reported to be impossible. Thus, manufacturing for other countries is possible only by utilizing local raw materials that as finished or half-finished products have advantageous transportation rates, i.e., that in the terminology of Alfred Weber lose weight in processing. On the Gold Coast these conditions apply to the processing of aluminum (outside the report's terms of reference, in view of already existing plans), timber (developing), and oilseeds—but not to its main produce, cacao. However, to process the total Gold Coast output of oil seeds (palm-kernels, copra, peanuts) would provide employment for only 20 workers at British standards of productivity. Since only large-scale oilseed processing plants are economical, the size of the oilseed producing area effectively prevents the introduction of this industry to the Gold Coast.

In the West Indies, total raw material production might be considered sufficient to warrant export industries based on raw sugar byproducts (manufacture of chemical raw materials) and copra; however, with few exceptions each individual area appears to be too small to support such plants, and the cost of inter-island transportation prohibits processing in central West Indian locations.

In production for the local market, size is again a decisive factor. For example margarine consumption on the Gold Coast is so limited that total local requirements could be met by the employment of two workers operating at British standards of productivity. Obviously, a plant of this capacity can not operate economically. Wheat-milling for local consumption relying on imported grain would employ about 70 persons at British standards of productivity, thus requiring a plant of reasonable size. However, additional costs of transportation, including fuel requirements, would not make a flour mill an economic proposition.

Lewis applies this type of analysis to the items that appear on the Gold Coast list of imports. He recommends the introduction of the following important manufactures: beer, cement, glass, industrial alcohol, as well as salt provided tribal rights on the coastal lagoons of the South East of the Gold Coast (where the salt would be obtained by evaporation of sea water) are clarified. The prospects for the manufacture of soap, paints, boots, etc., as well as for weaving and foundry products, are reported to be marginal, i.e., probably requiring financial assistance. Among these marginal industries, however, Lewis recommends the encouragement of weaving and foundry products since these are "most capable of rapid expansion if they prove successful" (p. 7). On the basis of this same type of analysis, Lewis does not recommend establishment of the manufacture of wheat flour, matches, stationery, etc.

Despite a more empirical approach, the list of industries recommended for the West Indies is very similar to that of the Gold Coast. Both reports recommend the utilization of railroad repair shops as nuclei for industrialization, for example by providing repair services for other industries. Similarly, the encouragement of tourism is recommended because the services required by visitors from abroad induce the growth of local contracting, manufacture of furniture, etc. In conclusion, both reports agree that any further growth in industrialization can follow only upon an expansion of agricultural production; and Lewis even goes further in recommending a return to plantations as an alternative to government subsidized pioneer cultivation on small holdings, for the purpose of encouraging the cultivation of specialized crops suitable as industrial raw materials, e.g., tobacco, sugar, or fibers.

ALEXANDER MELAMID

New School for Social Research

Rice, by D. H. GRIST. xix and 331 pp.; maps, diagrams, tables, ills., bibliogr., appendices, index. Longmans, Green and Co., London, 1953. £1/15/0. 8¾ x 5¾ inches.

Though our textbooks agree that rice is the world's most important single crop, seldom do they adequately cover the subject of rice growing the world over. The volume under review, written by a British Colonial Service agricultural economist, is a most welcome addition to the literature on the rice plant and rice growing techniques. It is a comparatively brief volume which nevertheless manages to deal with almost every aspect of the botany; physiology; climatic, soil, and water environment; agricultural techniques; handling; and production of rice. Its 17 chapters each deals with a different aspect of the plant, its care, and with rice as a grain. A good bibliography is listed in the abbreviated English manner, and a very good index makes the volume easy to use. An excellent collection of photographs illustrates the plant, fields, techniques, and equipment in all parts of the world, supplemented by numerous line drawings. For completely map minded geographers the two maps are less than completely satisfactory, but they are the least important aspect of the author's treatment. His particular contribution has been to gather agricultural data in comparative form in each subject chapter from all parts of the world in which rice is grown.

Grist begins his study with a short discussion of the origin of domestication of the dozen species of wild rices now known from southern Asia and

Africa. Though this is the least full treatment in the book, it is clear that domestication was no simple matter of subjugating a single species of wild plant, as is so often stated in the conventional descriptions. Grist is less interested in this phase of the rice story than in its modern handling, but it appears to this reviewer that further pursuit of the early history of rice domestication will ultimately reveal a history as complex as those being unravelled around the development of the other great basic grain crops, the maizes and the wheats.

Though rice seems to prefer heavy acid soils it is clear that the characteristics of soil and the degree of soil acidity have very wide ranges in different parts of the rice-growing world, and that soil acidity changes during the growing season in a single field. The chemical composition of rice field soils seems less important to yields than the conditions under which rice is grown, so that good farming practices adjusted to local conditions are the primary factor in productivity of the rice plant. One of the chief of these practices, of course, is the controlled provision of water in the right amounts at particular times during the plant production cycle. Water supply provision, control, and drainage of fields forms the largest element of cost in wet-field rice production. Several chapters deal comparatively with detailed methods of cultivation, water control, pests, diseases, fertilization, and the food requirements of the rice plant. A short chapter deals with the subject of comparative dry-field cultivation of rice throughout the rice-growing world, leading to the conclusion that its possibilities have been neglected in the concentration on wet-field cultivation. With good farming practices dry-field rice production can be significantly increased on the non-cultivated lands in the humid areas of the earth, and perhaps eventually in the sub-humid zones.

A significant chapter considers the problem of mechanization of rice farming on both wet and dry lands. The indications are that considerable progress is being made in several widely separated portions of the earth. Perhaps in the near future inventiveness will provide effective and cheap equipment to permit the revolution in rice growing that has come in recent decades to wheat and maize cultivation. Photographs of the current equipment and techniques in use in different areas add to this text discussion.

A series of chapters effectively deal with the subjects of storage, milling, nutritional values, production, yields, and consumption, all handled in comparative fashion. Under nutrition attention is given to the recent world-wide developments in under-milling, parboiling, enriching, and other methods of preserving the high nutritional values of rice that have been destroyed in the evolution of commercial milling practices which increasingly accompanied the growth of modern international trade in rice. In discussing production it is clearly brought out by both tables and text that, though rice is grown from the equator into the high latitudes, it does best in the sub-tropical parts of the world, and that the greatest per-acre and total production continues to lie in these areas. This is in good part a climatic factor related to the hours of sunshine during the growing period. From data inferrentially presented by Grist, and being gathered by this reviewer, it appears that rice is not properly a tropical plant, but one most at home in the sub-tropics where the periodicity of photosynthesis best develops a higher yield than in other climatic zones. Historically, rice is not very old as an important crop plant in the equatorial regions, and it still is in process of experimentation in the middle latitudes.

This volume is one in a projected series on tropical agriculture being published for the British Colonial Advisory Council of Agriculture, Animal Health, and Forestry. It is an excellent study of real value to regional and agricultural geographers, and merits serious reading by all those interested in the future development of tropical and sub-tropical agriculture.

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